

GRAPHICS CARD BUYER'S GUIDE

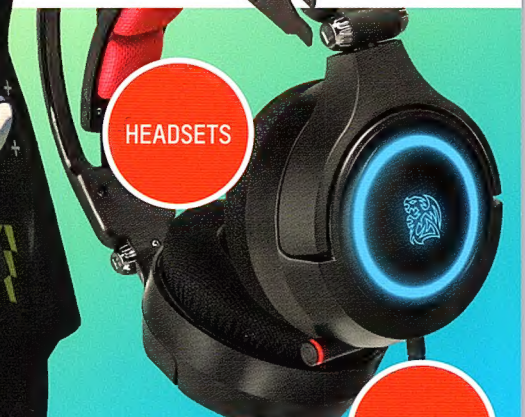
GET THE MOST FRAMES FOR YOUR BUCK, NO MATTER WHAT YOUR BUDGET!

2017

Nov 2017
Issue 447

YOUR EXPERT

GUIDE



HEADSETS

MICE

KEYBOARDS

DESTINY 2
REVIEWED!
SEE PAGE 110

PC GAMING ANNUAL

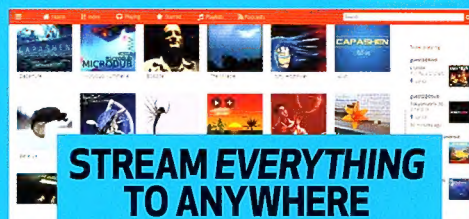
SPECIAL ISSUE: THE BEST GAMING GEAR ON TEST
MONITORS, MICE, KEYBOARDS & HEADSETS FOR EVERY BUDGET!

DISCOVER NEAT TRICKS IN OUR TECH TUTES!

- BUILD A THREADRIPPER PC
- SAFELY STORE CRYPTOCURRENCY USING A RASPBERRY PI
- HOW TO USE 12 AWESOME HIDDEN FEATURES IN MACOS
- WHY ANDROID OREO IS A GAME-CHANGER FOR SMARTPHONES

EXPERT REVIEWS OF HOT NEW TECH

- THE PERFECT GAMING LAPTOP? AORUS'S NEW 17-INCH STUNNER
- LATEST APPS FOR PC, MAC, LINUX & MOBILES
- AMD'S BABY RYZEN 3 1200: IS THIS \$149 CHIP THE NEW BUDGET KING?



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Future

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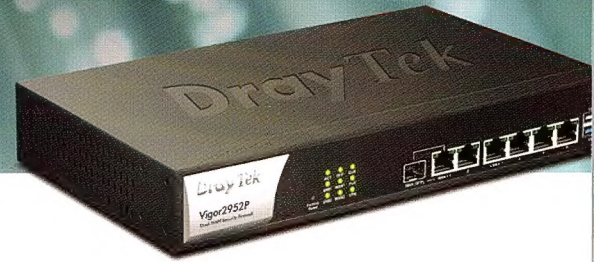
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- Dual-WAN Broadband Fibre Router with Security Firewall
- 4 x PoE LAN ports (power budget up to 60 Watts)
- 100 x VPN and 50 x SSL-VPN tunnels



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Application Example:

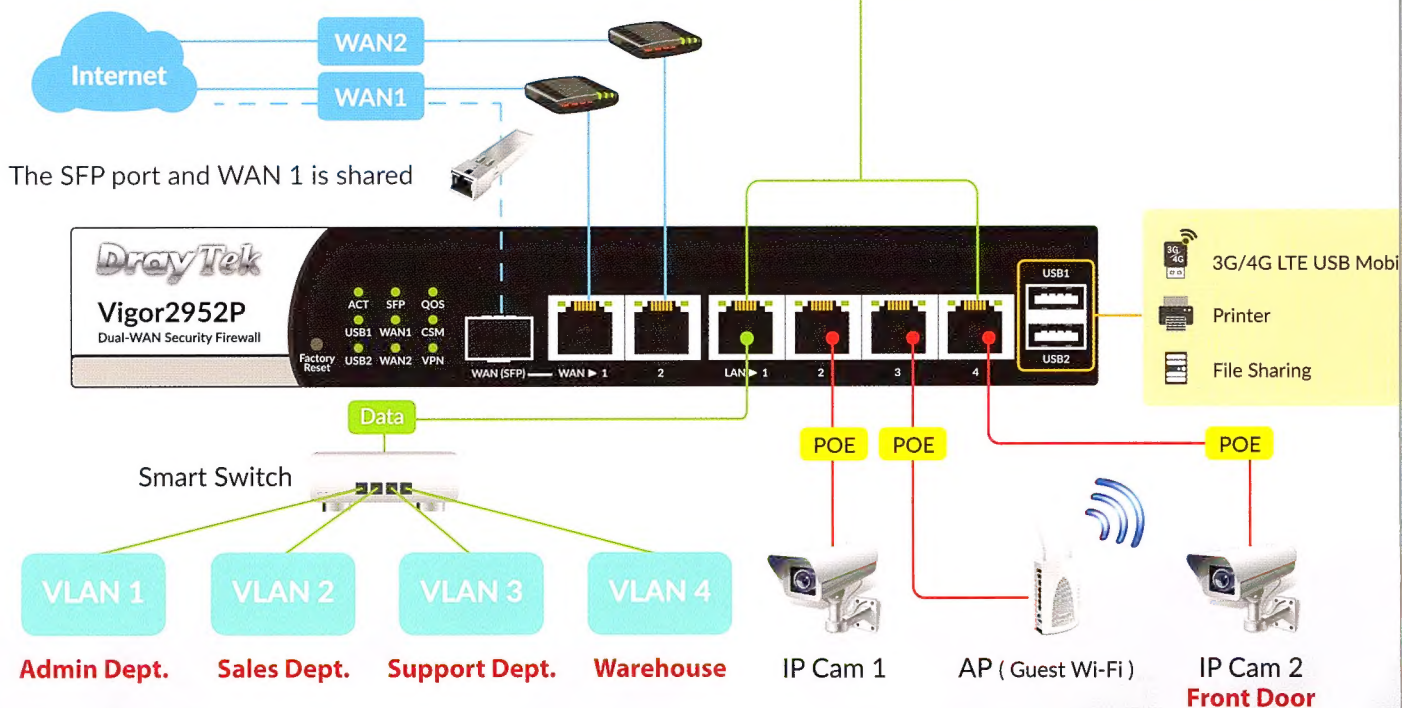
(A Vigor2952P supports 4 departments with router and PoE functions)

2 x Gigabit Ethernet WAN Ports

(ADSL2+/VDSL2, Cable, Optic Fibre and NBN NTU)

4 x Gigabit PoE LAN Ports

(8 Private LANs + DMZ LAN + IP routed LAN)



- 1 x Gigabit Ethernet/SFP combo WAN port
- 1 x Gigabit Ethernet WAN port
- Multi-WAN Load Balancing & Failover
- 4 x Gigabit PoE Ethernet LAN ports with 60,000 NAT sessions
- Complies with 802.3at Power over Ethernet Plus
- Supports PoE power up to 30 watts for each port
- Total PoE power budget up to 60 watts
- 1 x USB port (USB3.0) support 3G/4G LTE mobile broadband access
- 100 x VPN and 50 x SSL-VPN tunnels with Central VPN Management, VPN Load Balance and Redundancy

- Object-oriented Firewall with Content Security Management (CSM)
- IPv6 & IPv4
- Comprehensive QoS features
- Multi subnet WAN/LAN through 802.1Q
- 1 x USB port (USB2.0) support file sharing, external storage, network printer or thermometer
- Central AP Management (up to 30 Access Points)
- Central Switch Management (up to 10 Switches)
- Smart Monitor Traffic Analyzer (up to 100 nodes)
- Works with VigorACS SI management system
- High Availability Mode



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Good password habits, part 2

Continuing on from last month's column,
APC's editor shares his other key bit
of password advice.

In last month's editorial, I harped on about good password practices, and this issue, I'd like to share a bit of other password know-how – it's something that we touched on, but didn't really dive too deeply into, in last issue's security cover story.

I personally still advocate that everyone should use a password manager (like KeePass, Lastpass or 1Password) to ensure their accounts are kept as secure as is reasonably possible. That's not practical in all security situations, however, so what should you do when you have a password you need to remember and manually type out, but can't use your password manager? For example, the password you use to unlock your password manager – the whole idea of using one of the latter is that they generate super-secure random strings of characters for passwords, and save them, so you don't ever have to remember those strings. However, creating such a secure password with your password manager for your password manager would be a recipe for digitally 'locking your keys in the car'.

In such cases where you can't use your password manager, I favour the 'long memorable phrase' approach. This is where you pick a phrase that you can easily remember, then add a number and a couple of capital letters to it. For example, you could go with something like "APC is my favourite

tech magazine", and add a couple of the traditional 'good password practice' elements in there, like using '4487' in the middle, and capitalising a couple of letters – so that you end up with something like "APC is my favourite 4487 tech magaZine".

There's a few reasons this is a better practice than the standard 'secure' password approach most of us know of combining a word and a number (ie. "password1234"). Firstly, the longer your password, the harder it is to crack mathematically – every extra character you add exponentially increases the difficulty. Second, spaces count as special characters (in the same class as symbols like # or \$), making them especially tough for 'dictionary attack' style password-crackers to handle – they're another nice way to increase the complexity of your password without making it harder to remember.

Obviously, you don't want to use this method for *all* your passwords (unless you like typing them in), but in conjunction with a password manager, this is an easy way to bulk-up your digital security. ■



DAN GARDINER
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Contenders

Issue 447 November



PC GAMING ANNUAL

SPECIAL ISSUE: THE BEST GAMING GEAR ON TEST —
MONITORS, MICE, KEYBOARDS & HEADSETS FOR EVERY BUDGET!



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WE PIT TWO COMPETING TECHS
IN A HEAD-TO-HEAD
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"It's a pleasure to type on ... and is as sturdy as a mountain goat (and weighs about as much as one too)." Logitech G613, page 48



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» HOW TO DOWNLOAD YOUR FREE FULL-VERSION PROGRAMS

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GIFT 01



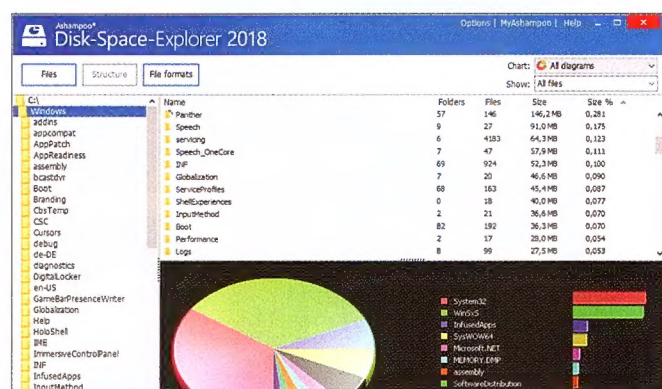
DETECT HIDDEN DRIVE WASTAGE WITH EASE

Free up space with Ashampoo Disk-Space Explorer 2018

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The compact but powerful Disk-Space-Explorer 2018 provides a detailed overview of file distribution and disk space consumption. Unlike Windows Explorer, Disk-Space-Explorer 2018 lists results based on file types and helps quickly locate potential resource hogs. The file type filters are customisable making it easy to scan drives for specific files, like videos or documents. Bar and pie charts provide visual clues as to the percentage of disk space usage for each file type. For a more in-depth view, users can quickly navigate through folders and customise existing file type filters or create their own. With Disk-Space-Explorer 2018, users can finally find out exactly how much space their photos, songs, videos or any other files really take up.

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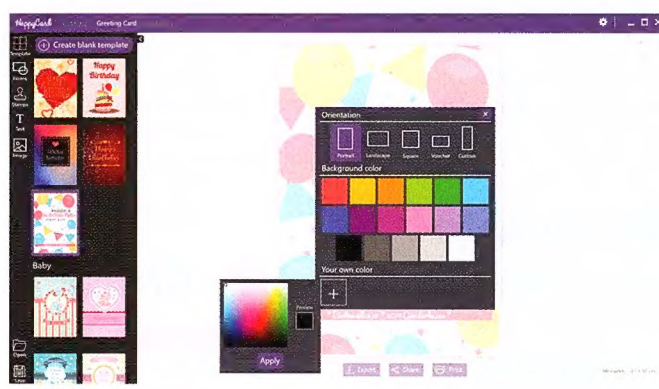
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technotes

» INSIDE APC



Inside APC

Find out all about APC's editorial policies, test practices, how to read the benchmark results and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for over 35 years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer – it's in our name, after all – the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech too, from smartphones and apps to peripherals, accessories, online services and beyond. We have two main goals: to track down the best of modern tech and also to help our readers make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And like you, APC's journalists want to know what's good in tech – no matter what platform it resides on.

INDEPENDENT REVIEWS

Championing technology doesn't mean we're unrelenting yes-men, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three.

As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

LABS TESTING

Despite being a small magazine with limited resources, APC still strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance, gaming and battery life.

In most cases, for the benchmark results published in APC, you can assume that higher is better. There are certain tests that deviate from this rule and where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter are our preference due to their ease-of-readability, but tables are more compact, so we use these in cases where thoroughness is preferred.

Severe Bluetooth security flaw affects over 5 billion devices

SMARTPHONES, LAPTOPS AND CARS AFFECTED.

Nearly 5.2 billion devices that use Bluetooth are open to attack from eight different vulnerabilities say researchers at Armis, and IoT security platform. Collectively known as BlueBorne, these flaws can not be detected or cured by traditional antivirus software, and do not need a user to initiate any connection. Simply having your Bluetooth turned on is enough for a malicious attack to potentially take place. Armis has contacted major hardware vendors, including Google and Apple, who will look at fixes. For now, APC recommends you turn your device's Bluetooth function off when not using it. PT

Google does \$1.25B deal with HTC for smartphone staff and tech

HTC FLAGSHIPS WILL STILL BE MANUFACTURED.

After months of speculations and rumours that HTC will be bought out, Google and the phone manufacturer have finally announced that the internet giant has acquired part of the HTC business, including some HTC employees, "many of whom are already working with Google to develop Pixel smartphones". The acquisition also includes a non-exclusive licence of HTC intellectual property, allowing the Taiwanese company to continue manufacturing its own products. SS

China bans anonymous online posts

CRACKDOWN ON INTERNET FREEDOM CONTINUES.

China has not only passed legislation that bans the use of virtual private network (VPN) services, the Communist regime is now cracking down on anonymous online posts on any digital platform, effective 1st October 2017. Service providers will be required to verify true identities of users during registration and will have to report any illegal content — a list broad enough to cover any topic — being posted online. SS



Aussie pirates in the crosshairs as Village Roadshow threatens to sue illegal downloaders

Freebooters, batten down the hatches!

Australia's largest film production company, Village Roadshow, hasn't finished its fight against piracy. Instead, it's trying to tighten the noose further, threatening to sue and fine individuals suspected of pirating content. Given how easy it is to circumvent the ISP blocks, Village Roadshow boss Graham Burke told Fairfax Media that "people who infringe [copyrighted movies] are people who steal, it's theft and it's not a victimless crime. There needs to be a price to pay. What we plan to do [is] sue people that are stealing our movies. So if someone steals *Red Dog* and *Mad Max: Fury Road*, we will sue them for the two viewings of those movies, plus some damages" incurred by the production company.

According to Burke, infringement notices will be mailed to alleged pirates "later this year" but legal action will be withdrawn if the person in question is in financial difficulties or suffering ill health. Village Roadshow will, however, need to convince ISPs to hand over personal information of the suspected infringers which, Burke said, could be done via the courts. Sharmishta Sarkar

NBN Co sets up new lab in hopes of resolving end-user faults more rapidly

THE NATIONAL BROADBAND SERVICE COULD BE IN FOR A TRANSFORMATION.

NBN Co has been in the spotlight lately, thanks to the myriad complaints rolling in from customers with regards to broadband speeds, or rather the lack thereof. After playing the blame game for a while, the company handling the national broadband service has set up a tech lab to help improve user experience. The lab will use the "existing capability to solve a complex problem" to provide "crucial insights about the way people are using the NBN network," explained NBN Co's chief systems engineering officer, John McInerney. The NBN lab will also utilise machine learning and graph technology to "help enrich the customer experience of services over the NBN access network and make our systems and processes more agile by synthesising massive datasets".

The idea behind the setup is that, when a complaint is filed, the tech lab will help determine whether the fault can be resolved remotely and instantly, or whether a technician needs to be sent to the premises. NBN Co says this will enable the company to understand and quickly resolve the key factors that drive customer dissatisfaction, saving the end user from experiencing disruption in service. Sharmishta Sarkar

Popular system utility CCleaner briefly hacked to spread malware

WERE YOU AFFECTED?

Piriform, the company behind the system cleaning utility CCleaner, has informed its customers that malware was found in an installation file for their program (version 5.33.6162). This particular installation was downloaded over 2 billion times and may have affected as many users, and while the company suggests it's likely an outside attacker, they didn't rule out the possibility of an inside job. If you use the program, visit www.piriform.com/ccleaner/download/standard to get a clean install of version 5.34. HD

Up to 20% of Aussies use video-on-demand service while on the toilet

TALK ABOUT CROSSING THE STREAMS.

A survey by telecommunications company Telstra reveals some surprising statistics about Australians and their video streaming habits. Telstra reported that 64% of commuters use their mobile device to watch movies and TV, and that — shock — 18–24-year-olds are the most prevalent, with 89% streaming on-demand content. The survey also reported that 19% of Aussies also stream while sat at the dinner table, and men are almost twice as likely as women to stream while at work (20% compared to 13%). PT

Lenovo fined US\$3.5 million over pre-installed adware on its laptops

SUPERFISH PROVES EXPENSIVE FOR THE LAPTOP MANUFACTURER.

Laptop manufacturer Lenovo found itself in trouble for violating US consumer protection laws for pre-installing a SuperFish-developed adware software on several laptops it sold in 2014 and 2015 that made the systems vulnerable to hacking. Although adware-installed Lenovo laptops stopped being sold in 2015, it's taken over two years for the Federal Trade Commission and the manufacturer to reach an agreement, with Lenovo being fined US\$3.5 million for the transgression. SS



facebook Ads

Facebook promises more transparency after Russian-bought US-election ads revealed

Too much information can be good thing.

Investigations have revealed that over 3,000 political ads on Facebook were paid for by Russians during the last US Presidential election campaign. Mark Zuckerberg has not only promised to release them all to the investigators, but is making political advertising more transparent on the social media site.

In the US, politicians are required to reveal who is paying for their ads on television, but that's not the case for adverts placed on social media. "Going forward... we're going to bring Facebook to an even higher standard of transparency. Not only will you have to disclose which page paid for an ad, but we will also make it so you can visit an advertiser's page and see the ads they're currently running to any audience on Facebook. We will roll this out over the coming months, and we will work with others to create a new standard for transparency in online political ads," wrote Zuckerberg on his page. Once the roll-out is complete, this will bring a whole new level of transparency in the 2020 race to the White House and in next year's midterm elections. **Sharmishta Sarkar**

If you go to The Pirate Bay, they'll use your computer to mine cryptocurrency

YOUR CPU IS IN FOR A BIG SURPRISE.

The Pirate Bay is now utilising your idle CPU to mine for cryptocurrency. Certain pages on the site will cause visitor's computers to work harder as they run an embedded digital-coin miner. Known as the go-to site to illegally torrent TV shows and movies, TPB is trialling new ways to make money in lieu of paid-for advertising.

"As you may have noticed, we are testing a Monero Javascript miner. This is only a test. We really want to get rid of all the ads. But we also need enough money to keep the site running," TPB stated in a blog post at thepiratebay.org.

The test had been running surreptitiously until users noticed a dramatic spike in their CPU's workload. According to TPB, a 'small typo' was to blame, and instead of targeting 20–30% of a visitor's processing power to the site, it was set up to utilise as much as it could get. That has now been fixed, and the embedded miner will only run in one browser tab, even if multiple tabs that are on the site are open. **Paul Taylor**

numbercrunch

» HARRY DOMANSKI LOOKS AT THE NUMBERS DRIVING THE BIG TECH NEWS



AMOUNT OF BITCOIN ATMS BEING INSTALLED ACROSS AUSTRALIA

ATM operator StarGroup will convert 2,900 of its existing ATMs across Australia into Bitcoin-enabled machines, in a new partnership with blockchain service provider DigitalX. This will mean that users will be able to both purchase Bitcoin with Australian dollars, or instantly cash in their Bitcoins for some cold hard cash. As it currently stands, cryptocurrency users often have to wait days to perform these conversions and while there are already some of these kinds of ATMs in service around the country, at last count, they only numbered 16 and were located solely in Sydney and Melbourne.



400GB

THE SIZE OF SANDISK'S NEW MICROSD CARD

It's perhaps no big surprise that SanDisk, a company best known for its mobile storage, is the one to break a record when it comes to microSD cards. The newly announced SanDisk Ultra microSDXC UHS-1 will be able to fit an impressive 400GB of flash storage in its thumbnail-sized chassis, and apparently it can also reach transfer speeds of 100MB/s. While we don't have Australian pricing at this point, it will cost US\$250 in the States, so we'd expect it to be around the \$400 mark over this side of the pond.



1.8 PETA BYTES

AMOUNT OF PORN THAT A USER UPLOADED TO TEST AMAZON'S UNLIMITED CLOUD SERVICE

Reddit user beaston02 has checked to see if Amazon's unlimited cloud service really lives up to its name — his tool of choice was an archive of nearly 1.8 petabytes of porn. Using scripts to record public webcams and automatically upload the digital video, the footage reached nearly 2 million gigabytes, roughly 293 years of 480p footage. The particular unlimited service that Amazon offered has since been scrapped... although beaston02 denies he had anything to do with this.



26%

PERCENTAGE OF AUSTRALIANS THAT "DON'T FEEL THEMSELVES" WITHOUT THEIR PHONE

More than a quarter of Australians "don't feel like themselves and find it hard to function" when without their phone, according to research commissioned by Chinese phone manufacturer Huawei. Of those that were surveyed, 96% admitted to carrying their phones with them at all times, and if they had managed to forget it when leaving the house, 37% would head back to grab it and be late for work, 45% would be late for meeting a partner and 34% would be willing to be late for a first date.



143 million

NUMBER OF US CITIZENS POTENTIALLY EXPOSED IN ONE OF THE BIGGEST SECURITY BREACHES EVER

A vulnerability in credit bureau Equifax's website has allowed hackers to gain access to personal files of a potential 143 million US customers — one of the biggest hacks of its kind. Details reportedly accessed included social security numbers, driver's licences and credit card details of the customers. Since the breach has affected nearly half the US population, a class action lawsuit has been filed, and the creator of the chatbot DoNotPay (initially set up to challenge US parking fines) has added functionality to "automatically sue Equifax for up to \$25,000" for negligence. ■

how it's done

Amazon Echo Show

We tear apart the online retail giant's smart AI speaker.



Is there an echo in here? Seems like Alexa's talking to us from a lot of devices now. The new Echo Show adds a screen to bring even more Alexa, so she can watch you while she listens. Creepy? Maybe. Endearing? OK, yeah, a little. Hey, Alexa, let's "Drop In" on another teardown!

MAJOR TECH SPECS:

- 7-inch touchscreen display with 1,024 x 600 resolution
- Dual 2-inch stereo speakers
- Intel Atom x5-Z8350 (2M cache, up to 1.92GHz) processor
- 5MP front-facing camera
- Eight-microphone array

KEY FINDINGS:

- Like most Echo devices, we start from the bottom. After peeling up the taped-in rubber foot, we spy a handful of T5 Torx screws. But with all screws dispatched, there are no seams — we seem to be screwed, for now. We hunt for new ingress points; it turns out the screws at the bottom were a red herring — the speaker grille is the real ingress point. Under the grille, we find some sound-dampening fabric (like the stuff rolled around the original Echo) and more screws.

- But still no dice removing that front panel — time to get to work on what looks like the digitiser. iOpener, engage! We lift the digitiser to reveal... more screws under the bezel! Unsurprisingly, the digitiser cable disappears into the frame, holding the digitiser captive for now. Fortunately, we can free the front frame, under which Amazon hid some hefty speakers. Our hard work and early screw removal pay off! Finally, we get to see what this Echo has to 'Show' for itself.
- Alexa's new form is powerful. How powerful? Well, the wall adapter outputs 15V DC at 1.4A, meaning there's 21W driving Alexa. Someone needs to pull Alexa back down to earth, and luckily we spot

a burly braided cable grounding the Show. That juice is going somewhere, and it looks like those speakers are thirsty. Out comes the main board, hiding its chips under an inscrutable jigsaw puzzle of EMI shields.

- The display itself is another matter. It's guarded by some impossibly tough foam tape that requires you to break the display rather than lift it out. So first we did the former, then the latter. The panel is a model TV070WSM-NMO, made by BOE. We half expected it to be borrowed from the similarly-specced Kindle Fire, but we've not seen it before.
- Repairability Score: 4 out of 10 (10 is easiest to repair). The Echo Show uses standard T5 and T6 Torx screws. While they may not get much wear, the most wear-prone components (buttons and power jack) are soldered to boards, which complicates replacement. The digitiser is not fused to the display, but must be pried up from tough adhesive to do any repair. The display is adhered tightly in the mid-frame, and is difficult to remove without damage. Any repair requires cutting through and replacing lots of tough adhesive. ■

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit: www.ifixit.com.

gadgets

» GEAR WE WANT

B.ONE HUB

Make anything a smart device.

\$650 | WWW.B1HUB.COM.AU

If Google Home isn't enough to satisfy your ambitions for the perfect smart home, the skateboard shaped B.One Hub can flip a few new tricks that'll greatly expand the number of devices you can hook up to the internet. In addition to plain old Wi-Fi connected devices, the B.One Hub integrates Bluetooth, Zigbee and Z-wave IoT protocols, giving you direct access to basically any IoT device you can think of. But the B.One Hub's wings also function as infrared signal blasters, meaning it can work like a universal remote to connect 'dumb' devices – everything from old AV receivers to air-conditioners – with the smartphone or voice assistant controlled app. **JB**



KEF LS50 WIRELESS

Our favourite bookshelf speakers, now with wireless.

KEF.COM | \$3,799

KEF's LS50 bookshelf speakers were an anniversary special from one of the best audio-manufacturers out there, and quickly became famous for serious sound quality in a small package. Now KEF has added to that great mix. The speakers have an unusual design in which the small tweeter sits at the centre of the bigger main driver. There's now an audiophile-quality amp built in, as well as wireless connectivity – so you can stream from your smartphone or plug in gear such as a turntable to get sound out as if you had a full hi-fi system. Could be a great buy for music lovers who don't have loads of space.

B&O BEOPLAY E8

Make talking to yourself cool.

\$449 | WWW.BEOPLAY.COM

Bang & Olufsen has decided to ditch the cords entirely with a new pair of high-resolution earpods, collectively called the Beoplay E8. Like most things that come out of B&O, these in-ear wireless headphones look great and come with a compact charging case to keep them together when they're not filling your pinnae. While these little buds don't have active noise canceling, they do include occlusion-reversing audio transparency mode, which allow outside sounds in and can relay calls and voice messages to and from your phone's Siri or Google Assistant. **JB**





HYM ORIGINALS SEED

Get your retro on!

US\$735 | SEED.HYM-ORIGINALS.COM

HYM Audio's new Seed audio player looks vintage, but there's nothing old-school about the tech. The Seed is an all-in-one Wi-Fi and Bluetooth system with capacitive touch controls and built-in speakers. In short, it's all you need to get the party started. There are two built-in speakers sitting underneath the record deck. Each features a one-inch silk tweeter and a four-inch Kevlar woofer, powered by a 70-watt amplifier. The Seed is designed to deliver a warm-sounding vinyl experience with top-notch audio quality, with an Audio-Technica AT3600 Hi-Fi MM phono cartridge. While the turntable is tuned to offer a flat-frequency response, you can tweak the bass and treble levels via the included remote control. It also streams music. Choose from Bluetooth or Wi-Fi streaming via the Seed app (iOS, Android) or via touch controls at the front of the player. The app also features integrated support for services including TuneIn, Tidal and Spotify Connect.

BENQ GS1

Streaming all over your walls.

\$999 | WWW.BENQ.COM.AU

It's not every day that you get a portable projector that can throw a HD screen up to 100-inches on any flat surface without any cords or cabling whatsoever. The GS1 is a little bigger than some of the portable projectors we've previously looked at, but with a 100,000:1 contrast ratio, a HDR-capable colour gamut, 300 Lumen peak brightness and three-hour battery life, it offers up far more than your average mini projector. BenQ's even integrated an Android-based OS and interface on the device, which'll allow you to watch titles from your favourite streaming service over Wi-Fi without the need to connect an external player. JB



FOSSIL Q EXPLORIST

Finally, a smartwatch that hasn't forgotten about style.

€319 | FOSSIL.COM

Fossil is releasing a new range of smartwatches, including two of the touchscreen variety – the Q Explorist and the Q Venture. The Explorist is the bigger of the two, and while we know size doesn't matter, we're digging the Q Explorist's handsome 44mm stainless steel case. It's also compatible with a range of interchangeable 22mm straps and bracelets. (The Q Venture, meanwhile, only comes in rose gold and gold with embedded gemstones.) This rugged-looking smartwatch features a digital crown on the right-hand side, designed for quick navigation through the user interface, and two programmable buttons on the right-hand side for further fiddling of your choosing. The Q Explorist's bright, always-on round touchscreen display throws up messages, smartphone notifications, date and time, and activity data (steps taken); choose from different watch faces to influence what data and info is displayed. In terms of internal spec, there's a Snapdragon Wear 2100 processor and 4GB of memory. Aside from the usual culprits such as an alarm clock, microphone and speaker, the watch also has an LED Flashlight function. ■

IFA 2017 show report

Held in Berlin, Germany, IFA is Europe's biggest annual tech show and it's increasingly a hotspot for PC-oriented product announcements and launches. We sent our CPU specialist, Josh Collins, to find out what was hot in 2017.

Intel hosted APC throughout the IFA trip, which delivered numerous opportunities including technical briefings directly from the chip-maker itself as well as invitations to launch events and booth tours from Intel partners, interview opportunities with vendor reps, and the always interesting discussions between international media often covering local and/or regional trends.

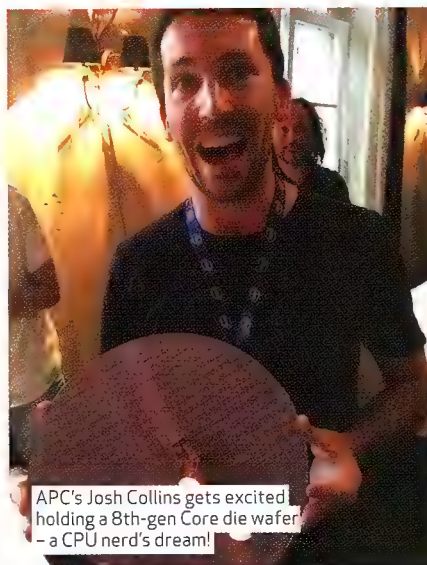
Also invaluable were open discussions with two of Intel's top brass: Chris Walker, Vice President in the Client Computing Group and General Manager of Mobility Client Platform Group for Intel Corporation, and Steve Shakespeare, leader of the Retail Sales Team for EMEA (Europe, Middle East and Asia).

A lot was covered during our few days on the ground in Berlin and we've rounded up the key product-oriented points for this story.

INTEL'S 8TH-GEN CORE i ARRIVES ON MOBILE

For Intel, the big focus at IFA was its unveiling of its new range of processors, which continues the generational-branding with an 8th-generation of Core i processors.

Unlike previous generational iterations, the 8th-gen Core i release isn't associated with a new micro-architecture or a step-down in manufacturing process. Instead, Intel's focus has been refinement. Whether the refinement is in the manufacturing process (which has moved from 14nm to '14nm Plus'), the CPU die arrangement (architectural), the chip resource allocation (architecture/platform) or streamlining through integration of hardware based solutions that were previously software driven (think of the 4K HVEC encode/decode gains made between 6th- and 7th-generation Core i processors through integration of hardware-based processing), there's been a focus on increasing efficiency and refining existing designs rather than creating clean-sheet solutions. The focus has allowed Intel to deliver to market an iterative gain while allowing for innovation



APC's Josh Collins gets excited holding a 8th-gen Core i die wafer – a CPU nerd's dream!

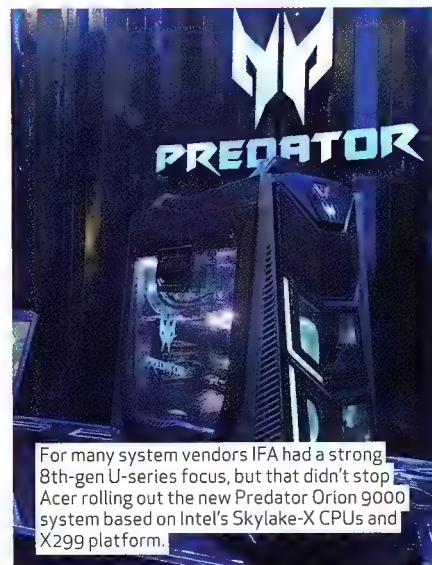
within the same generational chain link.

Now, for some purists, this shift in approach will certainly rub against the established grain. Enthusiasts considering 8th-gen Core i will, in the bigger picture of mobile and desktop processor solutions (many yet to be announced or launched), play host to numerous architectures within the generation. For example, Intel is launching the mobile U-series based on Kaby Lake (or specifically, what Intel's calling 'Kaby Lake Refresh') while the upcoming consumer desktop 8th-gen Core i processors will be based on the new Coffee Lake (specifically Coffee Lake-S) and speculated for a Q4 2017 release – though at IFA, Intel was playing coy about specifics on anything beyond the mobile 8th-gen Core i chips.

SO WHO'S 8TH-GEN CORE i FOR?

When it was developing its 8th-gen chips, Intel conducted market research and found that users seeking-out Core i-based PCs were primarily doing so with productivity, entertainment, content creation and online shopping usage in mind. Secondary usage-needs included communication, general web browsing, gaming and storage.

These usage scenarios confirm a fact many PC enthusiasts (and marketers) have always believed, but that there



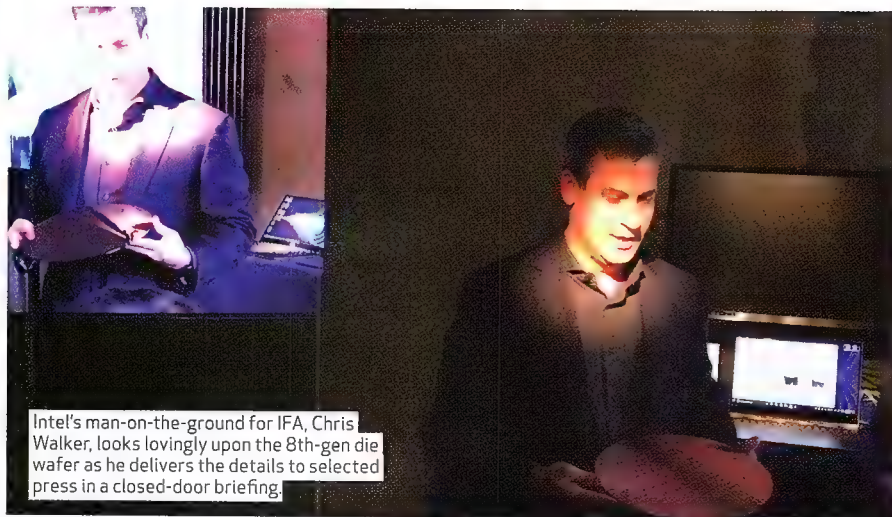
For many system vendors IFA had a strong 8th-gen U-series focus, but that didn't stop Acer rolling out the new Predator Orion 9000 system based on Intel's Skylake-X CPUs and X299 platform.

wasn't much hard data on. Intel itself sees the PC platform as an enduring one, which continues to provide the flexibility required to innovate and adjust to market pressures while also offering the stability of an established platform. Oh, and there's no forgetting the juggernaut that is PC gaming, especially the drive of the eSports sector.

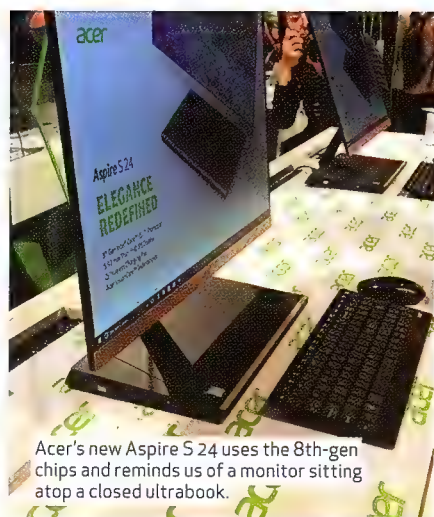
Intel's research also lead to the discovery there are more than 450 million PCs in the market that are five years or more old. With that aging mass of devices, Intel believes that continued innovations by device-makers such as Acer, ASUS, Dell and Lenovo will pave the way for a new era of growth. Naturally, Intel hopes this new era will be driven by its own 8th-gen Core i chips... but what's the motivator for these end users to upgrade?

8TH-GEN CLAIMS PERFORMANCE LEAPS, NOT STEPS

Intel's first 8th-gen Core i parts to land are its U-series of mobile processors. These are low-power and low-TDP solutions (15W base, configurable to 25W) designed for thin-and-light laptops, 2-in-1 computers, convertibles and mini PCs. Intel also offers the Y-series (for thin fanless detachables, always connected PCs), H-series



Intel's man-on-the-ground for IFA, Chris Walker, looks lovingly upon the 8th-gen die wafer as he delivers the details to selected press in a closed-door briefing.



Acer's new Aspire S 24 uses the 8th-gen chips and reminds us of a monitor sitting atop a closed ultrabook.

(performance laptops and mobile workstations) and the S-series for desktop use from value-oriented (entry-level parts, such as Pentium chips) to performance chips (high-end, overclockable K SKUs). For all the latter series, 8th-gen Core i will launching in the coming months – for now, it's just the U chips.

Intel's made some significant performance claims for this new U-series launch. Starting with up to 40% performance improvement over its predecessor (the Core i7-8550U versus Core i7-7500U are Intel's specific point of reference), that's a very sizeable gen-on-gen gain. Additionally, versus the five-year-old install base, Intel is claiming up to 2x better productivity performance and up to 1.9x better web performance from an 8th-gen Core i5 versus a five-year-old PC.

We spoke to Intel's Chris Walker about this claim, pointing out that this kind of performance gain hasn't been witnessed since the move from Pentium D to Core 2 Duo on desktop. Walker gave a wry smile and simply

replied, "I'm glad you noticed the significance in this generational gain and we look forward to you testing the new processors." Consider that a challenge accepted. We've not yet been able to get our hands on any 8th-generation laptops, but we're definitely keen to see if the on-paper claims reflect the cold, hard silicon reality.

Like all big corporations, however,

Intel can't just make up a figure and claim it's valid without proof. And after digging through the fine print of the company's technical presentations, there appears to be some ambiguity as to what the exact spec of the company's typical '5-year-old system' is. In the presentation files there is reference to the 5-year-old PC utilising a Core i5-3317U, a CPU which was launched Q2 2012, so that does line up. However,

Intel believes devices based on its new CPUs will give a measurable and direct benefit for those looking for an upgrade, but were perhaps not excited by the last two generational refreshes.

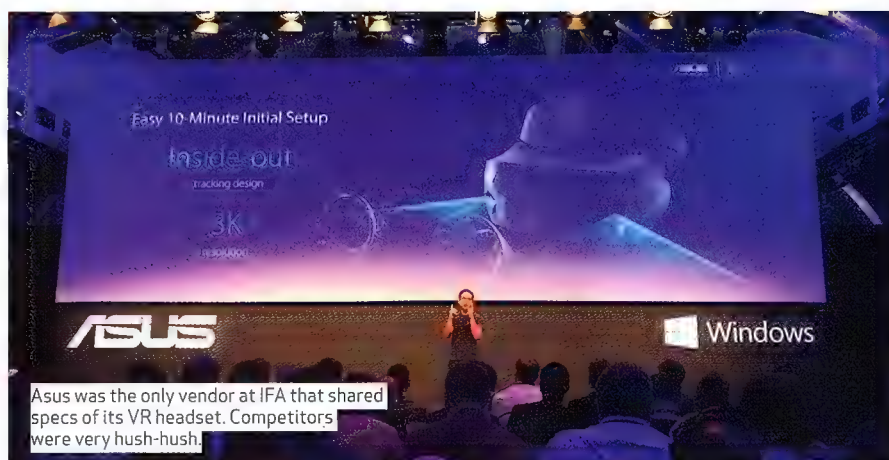
PAVING THE WAY FOR A NEW ERA

MORE THAN 450 MILLION 5-YEAR-OLD DEVICES

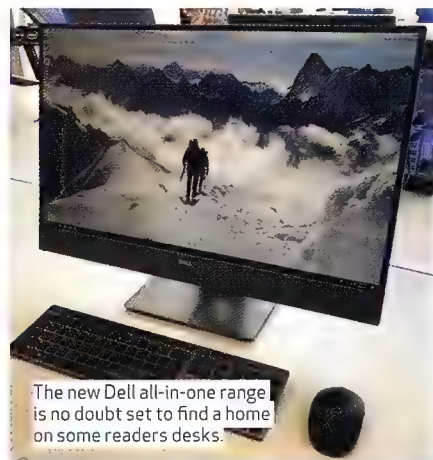
MORE VERSATILE DEVICES TODAY

INTEL CORE iU-SERIES CPUS COMPARED						
	CORE i7-8650U	CORE i7-8550U	CORE i5-8350U	CORE i5-8250U	CORE i7-7600U	CORE i7-7500U
ARCHITECTURE CODENAME	KABY LAKE REFRESH	KABY LAKE REFRESH	KABY LAKE REFRESH	KABY LAKE REFRESH	KABY LAKE	KABY LAKE
PROCESS TECHNOLOGY	14NM+	14NM+	14NM+	14NM+	14NM+	14NM+
SOCKET	BGA1356	BGA1356	BGA1356	BGA1356	BGA1356	BGA1356
CORES/THREADS	4/8	4/8	4/8	4/8	2/4	2/4
BASE CLOCK	1.9 GHZ	1.8 GHZ	1.7 GHZ	1.6 GHZ	2.8 GHZ	2.7 GHZ
MAX TURBO CLOCK	4.2 GHZ	4.0 GHZ	3.6 GHZ	3.4 GHZ	3.9 GHZ	3.5 GHZ
MEMORY TECHNOLOGY	DDR4/LPDDR3	DDR4/LPDDR3	DDR4/LPDDR3	DDR4/LPDDR3	DDR4/LPDDR3	DDR4/LPDDR3
MEMORY SPEEDS	2400/2133	2400/2133	2400/2133	2400/2133	2133/1866	2133/1866
CACHE (L4 CACHE)	8 MB	8 MB	6 MB	6 MB	4 MB	4 MB
SYSTEM BUS	DMI3 - 8.0 GT/S	DMI3 - 8.0 GT/S	DMI2 - 6.4 GT/S	DMI2 - 5.0 GT/S	DMI2 - 5.0 GT/S	DMI2 - 5.0 GT/S
GRAPHICS	UHD GRAPHICS 620	UHD GRAPHICS 620	UHD GRAPHICS 620	UHD GRAPHICS 620	HD GRAPHICS 620	HD GRAPHICS 620
MAX GRAPHICS CLOCK	1.15 GHZ	1.15 GHZ	1.1 GHZ	1.1 GHZ	1.15 GHZ	1.05 GHZ
TDP	15 W*	15 W	15 W	15 W	15 W	15 W

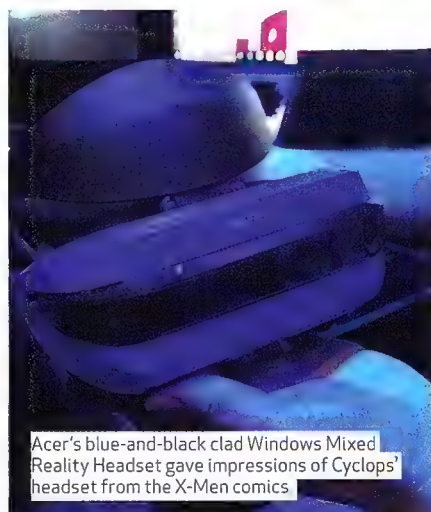
* = TDP configurable to 25 W



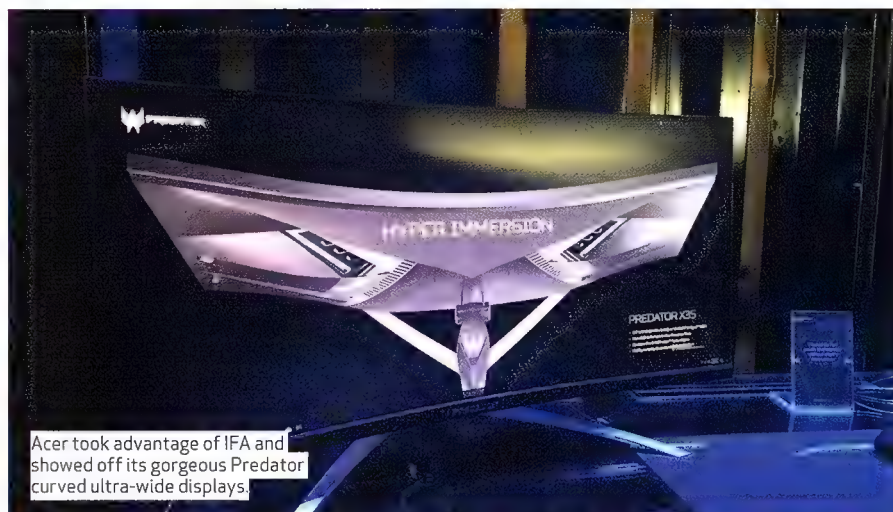
Asus was the only vendor at IFA that shared specs of its VR headset. Competitors were very hush-hush.



The new Dell all-in-one range is no doubt set to find a home on some readers desks.



Acer's blue-and-black clad Windows Mixed Reality Headset gave impressions of Cyclops' headset from the X-Men comics



Acer took advantage of IFA and showed off its gorgeous Predator curved ultra-wide displays.

Intel's online documentation makes reference to the Core i5-520UM, a CPU launched in Q1 2010 – well out of that 5-year-old band. Also noticeable were some quite-specific workloads used for reference testing.

We appreciate when manufacturers are transparent with technical comparisons, but a lack of clarity in reference documents does lead to an uneasy ambiguity. In short, we're looking forward to putting the 8th-gen processors and system through their paces in future issues.

ACER DOUBLES DOWN ON PC GAMING

One clear indicator of IFA's growing cred in the global tech space is that Acer's launch-event at the show was presented by the PC company's CEO, Jason Chan, who unveiled a number of new products, alongside revisions and updates to some existing models.

Of course, some of those packed Intel 8th-gen Core i chips, including a new Aspire S 24 all-in-one desktop PC, the Switch 7 Black Edition (a powerful 2-in-1), updates to the Swift product family of sub-1kg ultrabooks (some of which include inbuilt LTE) and the Spin 5 (a 360° 2-in-1 'flipbook').

Acer's also showed off updates around its collaboration with

Microsoft, with the pair working on a range of mixed reality (MR) headsets and the new MR functionality in the Windows 10 Creators Update, called Windows Mixed Reality Portal (and was previously known as Windows Holographic). Unfortunately there were no confirmed technical specs on hand for any of the headsets that Acer demoed – and all we really walked away from this thinking was, "Wow, change the blue to yellow on that Acer MR unit and it could be the headset worn by Cyclops in the X-Men cartoon."

Acer also used IFA to launch the Predator Orion 9000 desktop PC, an Intel X299-based gaming orientated super-system. The Orion 9000 supports up to the Intel Core i7-7980XE (18-core/36-thread) beast, 128GB of DDR4 RAM, has all-in-one CPU water cooling and case air cooling (all by Cooler Master), and is flush with RGB elements throughout. Buyers have the choice of either four Nvidia GTX 1080 Ti GPUs or three AMD Radeon RX 580. But for those of us that experienced 90s beige box PCs, the best part of the Orion 9000 is that it has a turbo button on the front!

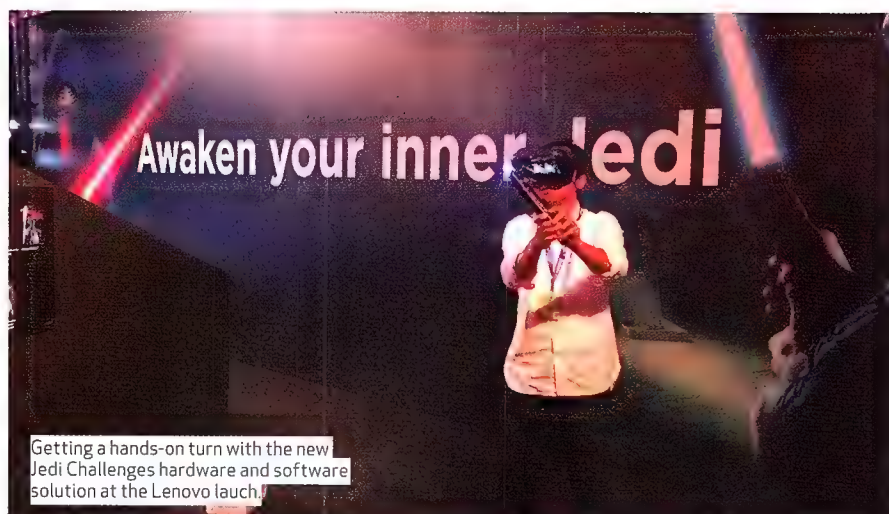
ASUS GETS MIXED (AND MORE)

Like Acer, ASUS was keen to use IFA to highlight its new 8th-gen equipped

machines, which, which largely took the form of updates to existing ZenBook laptops and 2-in-1s. That included the ZenBook Flip S, which was first revealed only a couple months ago during Computex with 7th-gen CPU, which will soon sport an updated to 8th-gen chip. (Our condolences to anyone who may have bought one in the interim.) Also announced were 8th-gen updates for the bigger (but still sleek) ZenBook Flip 14, ZenBook Flip 15 and the entry-level VivoBook Flip 14.

Not surprisingly, ASUS is also a partner of Microsoft for the Mixed Reality Portal project, with the Taiwanese device-maker is also making its own MR head-mounted display (HMD). The ASUS HMD for was announced without a specific launch product name, with the company instead simply calling the HMD 'ASUS Windows Mixed Reality' – no doubt a working title and a moniker we don't expect to enter the mainstream market.

Unlike its competitors, ASUS did provide some specifications for its HMD, however. The unit is said to feature 3K 90Hz display and will weigh less than 400g, which should help to avoid 'VR face'. Asus also mentioned it was using anti-bacterial fabric



Getting a hands-on turn with the new Jedi Challenges hardware and software solution at the Lenovo launch



The new Motorola Moto X4 has a gorgeous rear fascia that dances in the ambient light

materials to improve hygiene for shared use of the headset. Like all the HMDs in the Microsoft MR project, the unit uses inside-out tracking, with integrated forward-facing sensors.

Of course, ASUS has its fingers in many pies these days, and it also unveiled a range of other devices, including its first 802.11ax Wi-Fi router, the RT-AX88U 802.11ax, two new curved monitors, (the 21:9, 3,840 x 1,600 MX38VQ and 16:9 2,560 x 1,440 MX32VQ), what it claims is the world's first gaming laptop with a 17.3-inch 144Hz G-Sync display (the RoG Chimera) and a RoG XG35VQ 35-inch 100Hz curved gaming monitor.

DELL REDISCOVERS IFA

After a five-year absence from IFA, Dell returned this year with an interesting message that seemed to be along the lines of, "Even though we haven't been at IFA, we've still been kicking some butt." At least, that was the visual message we took away from its placement of recent global awards and accolades, which were proudly displayed front and centre.

Dell gave us a tour of its IFA booth and, true to expectations, was also all about Intel's 8th-gen gear. Starting with the laptop product range, Dell's popular XPS 13 and Inspiron 5000 and 7000 laptops will receive 8th-gen updates, and the company was keen to highlight the gaming chops of the Inspiron 15 7000, which will get both an 8th-gen update and an Nvidia GeForce GTX 1060 Max-Q graphics processor, stepping up from the previous-gen's GTX 1050 Ti.

Dell's all-in-one (AIO) PC range also saw updates to Intel 8th-gen Core i. This range is headlined by the Dell XPS 27 and features an inbuilt 10-speaker audio system for a fuller desktop audio experience, while maintaining the slim AIO form factor.

As with other large OEM vendors, Dell was front and centre with its contribution to Microsoft's Mixed

Reality Headset initiative, with a product it's simply calling the 'Dell Visor'. Unfortunately, no technical specs were provided beyond the ubiquitous statements such as 'integrated sensors for inside-out tracking', 'lightweight' and a 'flip-top display' – the latter of which is intended to allow easy disengagement from the MR experience without needing to fully peel off the headset and any other MR gear you happen to be sporting.

Dell's Alienware kit was on show too, with the Area 51 desktop PC and its signature triangular-design paired with the new 34-inch, 3,440 x 1,440-pixel 120Hz 1900R curved display, and new Alienware mouse and keyboard peripherals. The new mouse features detachable sides for a customised fit and there's Cherry MX Brown switches in the keyboard. After the tour we had a quick word with Hendrik Berkhof, Marketing Manager for Alienware, where we asked about the lack of a new gaming headset to join the mouse and keyboard. While nothing was confirmed, it was heavily hinted at that a new headset from the company is in the works to complete that Alienware gaming-peripheral ecosystem.

LENOVO GOES BIG

Lenovo's big IFA event felt like more of a concert than a product launch, with a large stage, loud PA system and seating for a couple-hundred media and guests. Presenting were a trio of Lenovo top brass alongside Chris Walker of Intel and, a little surprisingly, a VP from one of the divisions at Disney.

Lenovo had four key products at the show. The first – surprise, surprise – was an updated version of Lenovo's flagship 2-in-1, the Yoga 920, sporting an Intel 8th-gen Core i CPU. For those who want more than just an updated processor, the Yoga 920 Vibes delivers the same internal spec with a stylish cover design by Louis

Aymonod, a design student at the IED Milan Design School responsible for the competition-winning design featured on the 920 Vibes. And for those feeling the Force, there are special-edition Yoga 920 Star Wars units, which feature either a white/red Rebel Alliance inspired cover or a black/white Imperial one.

Also new was Lenovo's Moto X4 Android smartphone. This unit packs a sizeable 3000mAh battery, 16MP front facing camera with adaptive low light mode for a crisp selfie with friends, dual rear facing cameras with 12MP autofocus and 8MP wide angle support, plus IP68 water resistance. To demonstrate the IP68 capability, Lenovo set up multiple stands with Moto X4 units ready to take a swim.

There was also another Microsoft Mixed Reality Headset; Lenovo's calling its version the Explorer. There was little to differentiate it technically from the other offerings we saw from Acer, ASUS and Dell, with only ASUS providing any significant technical insight during IFA.

Lenovo did offer up one new mixed-reality reveal, however. Disney's Mike Goslin (who actually wasn't on stage for the Yoga 920 Star Wars Special Edition 2-in-1s), used the Lenovo MR announcement to reveal the first augmented-reality (AR) Star Wars game, dubbed 'Jedi Challenges'. This provides a variety of different AR experiences such as lightsaber duels, 'living space' RTS gameplay and Holo Chess, aka the chess-like game played by Chewbacca and R2-D2 in A New Hope. Jedi Challenges comes as a US\$199 kit which includes a Lenovo Mirage AR headset paired with a tracking beacon and a convincingly-realistic Bluetooth Lightsaber Controller – and you'll need to BYO fairly recent smartphone to actually power the Mirage. ■

epinions

BUDGET VIDEO-EDITING RIG?

Having read with interest your take on a budget gaming PC in issue 445, I would like to know if you have plans for a budget video making PC in the offing. I was thinking the gaming PC would fit the bill but then thought maybe a different processor and or graphics card might be better suited. Then I thought maybe it would need to be a different build altogether.

Perhaps an article on a video PC along the lines of the gaming PC article but with side steps where a bit more could be spent on, say, a different processor and less on a graphics card or more memory and so on, keeping the original budget about the same.

The original budget would need to be as low as possible, consistent with ending up with a PC that could do the job.

Maybe an article on video editing software as well? I presently use Adobe Premiere Elements 10, but will be shortly upgrading or trying something totally different.

Bob Nicholson

Ed replies: Building a video-editing rig for around that same \$1,000 price point as the budget gaming PC we constructed in APC 445 (see page 68) is a tough ask — the hardware demands for (competent) video editing are actually higher than what you'd get away with for basic gaming.

While you could certainly put together a system that'd be passable, you'd hit problems in most major areas — specifically, in not having a fast (and highly-threaded) enough processor, too little RAM, and not enough storage. A mid-range or above GPU is also very handy to have for video-editing these days, as basically all commercial editing programs support GPU hardware acceleration, which can make things both more responsive when you're working with a video file, as well as faster when it comes to encoding

Our budget gaming rig in APC 445 squeezed in at a little over a grand, but building a video-editing PC to that same price is a trickier prospect.



"Building a video-editing rig for around that same \$1,000 price point as the budget gaming PC we constructed in APC 445 is a tough ask — the hardware demands for (competent) video editing are actually higher than what you'd get away with for basic gaming."

your final videos. The Labs team is definitely keen to see what they can come up with, though, so stay tuned — although don't hold us to any promises about hitting that \$1,000 price!

NAS WITH WINDOWS SERVER CAPABILITIES

I have been using Windows Home Server 2011 for some years and am looking to replace it. I have read all of your reviews of NAS boxes and investigated their software and capabilities, but nothing appears to address the question of an equivalent for the Windows Connector software for servers. Is there a direct equivalent, or is there some other software or a

workaround for this very useful piece of software, within a NAS based system?

Michael Pollard

Ed replies: While NAS boxes have definitely come a huge distance in what they can do, as far as we can find, there's nothing out there that directly replicates what Windows Connector offers — which is, specifically, comprehensive backup and system monitoring for any client PCs on the same network. Let's open this one up to the APC readership: do any readers have experience with performing these kinds of tasks just using a NAS? ■

APCMAG@FUTURENET.COM

Come on, have your say!

We want to hear what you think. Add to these discussions or email your views (in fewer than 250 words) to apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

Can iterative devices justify their price tags?

The iPhone X is impressive, but it may also be too expensive to justify in 2017, writes Shaun Prescott.



In Australia, Apple's newly-announced iPhone X costs \$1,579 for the 64GB model, or \$1,829 for the 256GB model. Needless to say, unless you're Rupert Murdoch or Donald Trump, that's a lot of money to spend on a phone. Now, there is some justification for that price tag. Not only does the iPhone X boast a better OLED screen, but it nearly scraps the bezel entirely, alongside camera and AR tech that promise to be futuristic, even if rather superfluous (and in the case of Face ID, mildly alarming).

But who is it for? The wealthy, basically, or else people who really need to have the best available phone technology in their pocket and don't mind sacrificing a great deal else. People will buy it regardless, but as time goes by it seems increasingly silly to fork out too much on a smartphone because, let's be honest: these things just aren't built to last, nor are they meant to.

There are a bunch of factors that contribute to a smartphone's lifespan. How heavy a user are you, and how

many times do you charge it per week? According to Battery University — an independent battery testing company associated with battery analytics firm Cadez — your average lithium-ion battery can only handle between 300-500 charging cycles per lifespan, with a cycle consisting of any charge commenced when the phone is below 70% capacity. That means if you're anything like me, your battery is likely to start tapering off at around the one year mark.

While that's the most practical consideration, there are also other more nebulous things to take into account. Apple releases at least one new iteration on its phone per year, as do all of the Android brands. Is this \$1,579 going to feel like dead money this time next year, when Apple unveils new must-have concepts? Clearly this consideration isn't going to help enthusiasts who simply must own all the new tech, but for anyone thinking a more expensive phone signals a longer term investment, then... probably not, I'm afraid.

Because in addition to battery

degradation, alluring new models and the fact that you'll probably end up dropping the damn thing, Apple has a habit of rolling out new OS versions which, if they don't render your phone unusable if accidentally installed, may very well slow them down to the point of annoyance. This mild form of planned obsolescence is largely unproven with statistics but, in a New York Times article from 2014, the publication showed a graph that proved search queries for 'iPhone slow' tended to spike at a certain time every year.

The thing is, spending money on new phones feels really nice. But then, in a matter of months, you'll forget that your phone was ever a novelty at all. Then, if you're the soul-searching type, you may begin to wonder whether a \$1,800 phone makes you happier than a \$500 one. And you may discover that actually, it doesn't, and that this impulse to acquire may find a better salve in craft beer brewing or hobby trains. Buy the new phone by all means, just do so knowing that you might be up for another \$1,500 in less than two-years time. ■

END USER

Share your stories!

If you have an interesting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

Head to head: Mac vs. PC

In this regular monthly feature, Alan Dexter pits two competing techs in a head-to-head battle to decide which one is superior.



PC versus Mac. Mac versus PC. A debate that just won't die. That comparative proposition used to be pretty straightforward. The PC was clunky but configurable, the Mac pretty but painfully restricted. Today, the divide isn't so obvious. For starters, since Apple moved to Intel processors, it's been possible to dual-boot Macs into Windows. Equally, Windows machines such as the Surface Studio aren't just occupying similar creative territory as Macs, they're doing some things better. Time to have another look at this classic confrontation.

"As a physical object, the crazy-thin 12-inch MacBook is probably the single most gorgeous portable computer yet conceived."

Round 1

PLAYING GAMES

Of all the possible criteria, remits, and requirements, gaming provides the most unambiguous winner. It's a nailed-down, copper-bottomed certainty that the PC is the better choice. There are far more games for the PC, and where the same game is available on both platforms, it runs better on PC. The end.

Likewise, before anyone suggests using Boot Camp as a quick-change option for transforming a Mac into a gaming PC, that only works up to a point. That's because of a Mac's limited configurability. Trying sticking an Nvidia Titan Xp into a trashcan Mac Pro. Yeah, right. By contrast, the PC has a wealth of options in terms of components that enable you to max out your gaming performance at any given price point.

The possible exception to this may arrive with the upcoming new Mac Pro. Apple says the new model will major on configurability, so it's just possible that we may finally have a desktop Mac with some reasonable upgrade chops. In that scenario, dual-booting a Mac into Windows via Boot Camp might make a decent part-time gaming rig. Until then, it's PC all day long, and thrice on Sundays. See ya, Mac!

Round 2

BEING CREATIVE

Tricky one. Apple has long styled itself as existing at the intersection between liberal arts and technology. Although that rings faintly ludicrous when you consider its puritanical policing of software in its app store, there's no doubting that generations of content creators have favoured Macs.

Exactly how much better or worse Macs are for creating content is quite a subjective subject. But many people certainly do prefer the software packages and GUI of Mac in a creative context. On the other hand, whenever performance is a critical part of the package, Macs fall behind. Apple's Mac Pro workstation is staggering on with ancient hardware. In short, if you want to render in a hurry, choose a PC.

Macs also look rather old hat with the arrival of Microsoft's Surface Studio, and its intriguing form factor and input solutions. It's far more innovative as a content creation device than anything Apple has done for years—the touch bar on the latest MacBook Pros doesn't come close. For that alone, the PC deserves a marginal victory. However, when the new Mac Pro arrives next year, it could be a very different story.

Round 3

GOING MOBILE

What is the best laptop in the world? Quite often, the answer to that question has been some kind of MacBook. However, MacBooks needn't be the absolute best in every category to remain relevant.

The MacBook line is certainly more up to date technologically than Apple's tiring Mac Pro product, for instance. And when it comes to perceived quality, the best MacBooks are peerless. As a physical object, the crazy-thin 12-inch MacBook is probably the single most gorgeous portable computer yet conceived. You tend to know what you are getting with Apple portable, too. You can usually assume that great build quality and good battery life are givens. Usually! With PC laptops, it's often a bit of a gamble, especially if you are ordering online and sight unseen.

On the other hand, Apple boxes you in with a limited range of choices and configurations, a situation that is epitomized by the aforementioned 12-inch MacBook and its single USB-C port for everything. PCs can be had in all shapes, sizes, specifications, and prices. In the end, it all depends on your remit and the things you care about most. An honourable draw, then.

WINNER:
PC by a mile

WINNER:
PC by a hair

TIE:
PC and Mac



"The PC has a wealth of options in terms of components that enable you to max out your gaming performance at any given price point."

Round 4

EVERYDAY COMPUTING

Or to put it another way, what is the best overall combination of hardware and operating system? Macs certainly score in a number of areas. For starters, they present a more consistent face more of the time. Apple maintains closer control of both hardware and software, so you're less likely to face minor glitches, be that in terms of stability or interface quirks—when you can't easily blame someone else's hardware or the software, you just need to get everything working.

It's also true that, when equipped with a high-DPI display rendering in so-called "Retina" mode, the Mac has the PC beaten for the crispness of its fonts. They are gorgeous. Macs also integrate exceptionally smoothly with certain peripherals that have been designed for Mac (although that's a bit of a double-edged sword in the value department).

And yet macOS is very much a walled garden compared to the huge expanse that is the Windows ecosystem. Windows remains a little rough around the edges, even Windows 10. But if you're like us, and you want maximum power and configurability, as well as the broadest software and hardware compatibility, the PC has Mac comprehensively licked.

WINNER:
PC

Round 5

KEEPING SAFE

Cyber security is the bane of modern life. Even governments and major corporations regularly get hacked. For the average person on the streets, the safety and anonymity of numbers is probably the best protection. So, does it really matter which computing platform you choose?

In extremis, we concede the PC is probably the more vulnerable as an overall platform. That is simply a consequence of its ubiquity. It presents more live targets to the bad guys, so more of them are working on ways to compromise the PC than Macs. To put this in some kind of context, Apple lays claim to around seven percent of new computer sales, against a backdrop of consistently selling less than the likes of Dell, HP, and Lenovo for many years on end.

However, in reality, many of the threats to your online persona are platform-agnostic. If a minor website you use is hacked, and leaks a password that also happens to be the key to your online banking, it hardly matters what computer you use. In other words, in terms of the choices you can make to safeguard yourself, it's mostly down to how you manage your personal data, such as passwords, rather than which computer you pick.

TIE:
PC and Mac

And the winner is...

Scan the win-lose ratio and you might conclude that the PC has served the Mac with a brutal punishment beating. In practise, it's much more finely balanced. Partly that's because when Mac is at its best, we have no problem recognising that it can be utterly delightful. It's also worth remembering that Apple's well implemented Boot Camp dual-booting utility means you can often have your macOS cake and eat Windows at the same time.

Ultimately, however, so much of this comparison comes down to personal preference. For us, the power, flexibility, freedom, and configurability of the PC is what it's all about. If you're dead serious about getting things done your way, and not being held up or messed around by somebody else's idea of what makes a good computing platform, PC wins hands down.

Where Mac makes sense for us is as a secondary system with a relatively narrow remit. Powerful desktop PC at home; a thin slice of tasty Apple portability on the move. Sounds good to us. But if there could only be one, there can only be one. And it's the PC. ■



ALL-IN-ONE PC

\$2,699 | APPLE.COM

Apple iMac with Retina 5K display (27-inch, Mid 2017)

More of the same for Apple's big-screen Mac, but that's not a bad thing.

There's been a big wait for the latest generation of 5K iMac updates – almost two years. With that kind of gap, we were hoping for some truly big changes. However, it looks like we'll have to rely on the iMac Pro release in December for our fix of wild new features.

Firstly, that glorious 5K screen is basically the same. Same huge 5,120 x 2,880-pixel res, same 27-inch size, and the same wide P3 gamut for more realistic colours than the average screen. To its credit, the 2017 display comes with boosted brightness, and the difference is noticeable, adding an extra level of vibrancy that's pleasing. That's not a revolution, but it's impossible to overstate how impressive this screen is when it's packing a ridiculous amount of detail into images that really pop. The extra brightness also

helps curb reflections.

Let's move on to the iMac's innards, because the 5K iMac still represents Apple's most powerful computer that people actually buy. If it's purely processor power you're after, the bigger iMac isn't necessarily a must-buy over its 21.5-inch 4K iMac sibling. The top-end 4K iMac (\$2,199) and this entry-level 5K model actually share the same 3.4GHz quad-core Intel chip, 8GB of memory and 1TB Fusion Drive. The \$500 difference gets you the bigger screen and better graphics performance.

Apple offers a lot of iterations when it comes to processor, RAM and storage, giving you options to choose which model works best for you. The big iMac changes this year lie in graphics, with a speedy AMD Radeon Pro 570 with 4GB of video memory under the hood.

If you're not planning on gaming or doing 3D work,

the extra memory won't make much difference. But for those that do, it's an important upgrade. If you're doing that stuff you'll probably want to step up to the \$3,449 model, which comes with a faster GPU and 8GB of video memory.

Even if you're not a gamer or a 3D pro, you'll benefit from the graphics unit being generally more powerful – many apps, including Photos, take advantage of it to speed up certain tasks. In terms of storage, you get a 1TB Fusion Drive in both the entry-level 5K iMac and the next model up, with a 2TB drive in the top model. The flash memory is extremely fast (with read speeds of over 700MB/s and write speeds of 575MB/s), making the computer feel really snappy in use.

The 8GB of main system memory is enough for most home users, but you can add more when ordering from Apple, but you can install

more yourself.

You've also got additional ports with this model – two Thunderbolt 3 ports that double as USB-C, in addition to the same four USB 3.0 (Type-A) ports, SD card reader, and Gigabit Ethernet port as before.

As lovely as it is, the design feels like it's a bit behind Apple's other products. But these are minor irritations; the 5K iMac is still really strong, marrying satisfactory power with an unmatched display quality.

■ Matthew Bolton

Verdict

Features
Performance
Value



It's not especially cheap, but the 5K screen is fantastic, and this model packs plenty of power for most people.



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Lyra

AC2200 Tri-Band Whole-Home Wi-Fi System

Corner to Corner Wi-Fi

Smooth Wi-Fi, Everywhere

Tri-band Wi-Fi with dedicated 5GHz internet backbone for fast, reliable Wi-Fi in every room

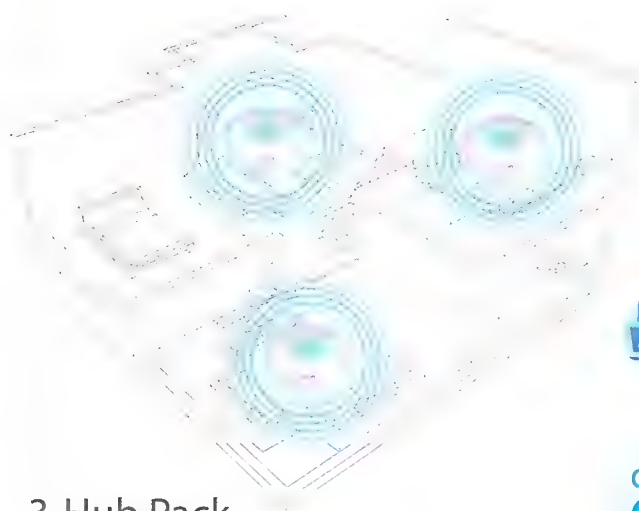
Smart Antennas, Smarter Wi-Fi

Automatically optimized Wi-Fi network delivers maximum performance in any home

Commercial-Grade Security

Free-for-life, self-updating ASUS AiProtection secures all connected devices

*Actual data throughput and coverage will vary from network conditions and environmental factors



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For Whole-Home Coverage



 ASUS Australia & New Zealand



www.asus.com/au/Networking/Lyra





GAMING LAPTOP

\$4,399 | WWW.AORUS.COM

Aorus X7 DT v7

A gaming laptop with everything you could want on paper, but does that add up in the flesh?

While the X7's subtly accented heat vents, unbelievably-thin 2.5cm chassis and wing-shaped speaker grill add up to an impressive spectacle, running your fingers over the materials used on this gaming laptop gives an even more visceral indication of the device's no-expense-spared approach. While the Aorus X7 DT v7 isn't technically an Nvidia Max-Q certified laptop, it still packs a top-end GeForce GTX 1080 GPU in a chassis that's incredibly thin.

The laptop's trackpad, emblazoned with the company's dragon-like falcon logo, is first rate. Add to this a full-size keyboard with per-key customisable RGB backlighting, good resistance and a generous travel distance (at least for such a slim device) and you've got inputs that are a cut above most others.

As impressive as these exterior elements are, they

are overshadowed by unusually high-end components, including an Intel Core i7-7820HK CPU, 32GB of DDR4 RAM, a 1TB Hitachi mechanical hard drive and a ridiculously-speedy 256GB Samsung M.2 PCIe SSD, which manages sequential read and write speeds of 3,252MB/s and 1,488MB/s, respectively. While that Core i7 CPU has a top clock speed that's 100MHz faster than the Core i7-7700HQ we're used to seeing in high-end gaming laptops, this doesn't really translate into a performance bump. Drill down into more specific CPU tasks, like CineBench's multi-threaded CPU rendering and HWBot's x265 1080p media-encoding tests, and you do see a 7.6% and 13.6% performance increase, respectively, over devices running the 7700HQ chip, like Gigabyte's Sabre Pro 15 (see APC 411, page 28) – good for anyone doing multimedia-centric work, but for most day-to-

day tasks the difference will be imperceptible.

Nvidia's GeForce GTX 1080 is the most powerful single-GPU available (for laptops), which means the X7 DT v7 has more than enough grunt to run the latest games faster than 60fps on ultra settings, but Aorus has added G-Sync and a QHD 1440p resolution to the 17.3-inch panel – demanding screen tech to challenge even the best graphics cards. The X7 DT v7 hits an average of 71.4fps on The Division using Ultra settings at a resolution of 1440p; that's fast enough to still get some value out of the faster refresh rate of the screen, but you will have to trade on the various quality parameters to find a balance that suits the style of game you're playing.

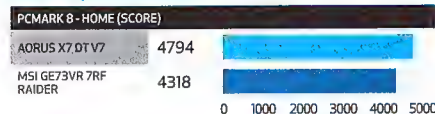
Dropping down one quality setting, resolution level or average framerate bracket is the closest thing to a concession you'll have to make with Aorus's X7 DT V7. Even the peak thermals of

the unit's CPU and GPU aren't stretched further than 86°C – at least at stock speeds. All this demanding hardware does draw heavily on the 94.2Wh Li-Polymer battery. Unplugged, the X7 lasted a middling 1 hour and 47 minutes in the PCMark 8 Home Battery (Accelerated) benchmark, but given all that power combined with a 17-inch display, there really isn't much here to complain about. If you're OK with dropping \$4,399 on a gaming laptop, this one barely sets a foot wrong.

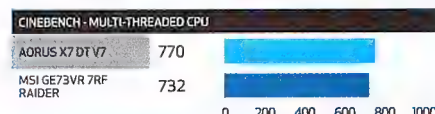
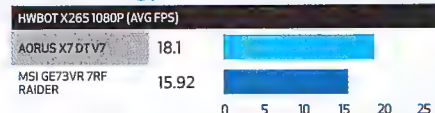
■ Joel Burgess

LABS BENCHMARK RESULTS

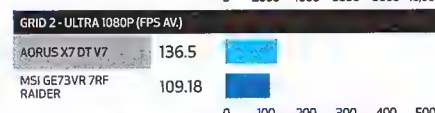
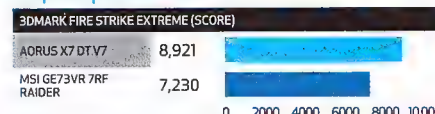
General performance



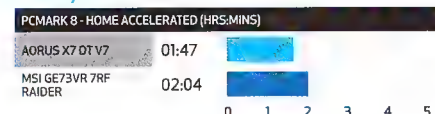
Media encoding performance



Graphics performance



Battery Life



Verdict

Features
Performance
Value



Manages to pack all the best features of today's gaming laptops into one sleek-looking package.





INTEL CPU

\$799 | WWW.INTEL.COM

Intel Core i7-7820X

Why some CPU cores are more equal than others.

Eighteen months ago, eight cores was as good as it got for desktop CPUs.

Not now. In this brave new post-AMD Ryzen world, it's half as many cores as AMD now sells you in a single CPU. It's not even half as many as Intel is planning by the end of 2017.

The new Core i7-7820 is Intel's latest eight-core chip, and it arrives with a street price of around \$799. That's not only close to double the cost of that Ryzen processor, it's also \$300 more than the next CPU down in Intel's new Skylake-X range, the six-core Core i7-7800X. Of course, not all CPU cores are equal. Hold that thought while we look at the 7820X's vital statistics.

Beyond the eight cores and Hyper-Threading-enabled 16 threads, the headline numbers look good. There's a 3.6GHz base clock, 4.3GHz Turbo clock, and 4.5GHz TurboMax speed. In other words, the 7820X packs a healthy combo of core-based parallelism plus

excellent single-core clock speeds. You also get 28 PCI Express lanes. OK, that's way fewer than the 64 you get with an AMD Threadripper chip, and it's a lot fewer than the 44 lanes Intel hooks up to the next CPU up in its own Skylake-X lineup, the 7900X. But it's probably enough for all but the most demanding of system configurations.

Of course, the other major feature that comes with the 7820X is Intel's peerless CPU core architecture. AMD's Ryzen cores are very good, but they're not quite this good. Which is why the 7820X blows every eight-core Ryzen CPU we've tested out of the water. OK, it's only a little ahead of AMD's fastest eight-core model, the Ryzen 7 1800X, in Cinebench's multithreading mode, and the 7820X only has a small advantage for video encoding, too. But it batters the AMD chip by 194 points to 159 in Cinebench's single-threaded mode. That's over 20% more performance.

In certain multithreaded workloads, it's a lot quicker, too. Fry Render gives the 7820X a 31% advantage for rendering. As for gaming, well, the raw numbers would have you thinking there's not much in it. In practice, AMD's modular Zen architecture can be stuttery in some game titles. It's not a widespread issue, but Intel remains the obvious choice for consistently smooth performance in the widest number of games.

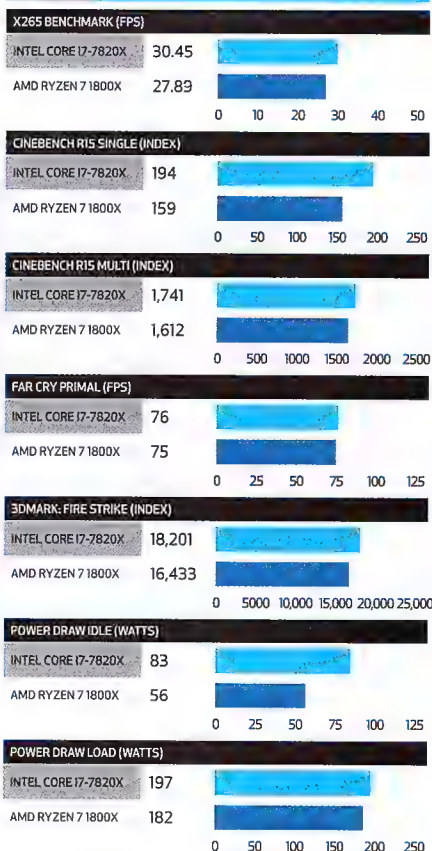
All of that applies to the 7820X running at standard clock speeds. Thanks to an unlocked CPU multiplier, you have easy access to cranking up the frequencies, too, if that's your bag. In the end, then, Intel's marketing boys aren't completely crazy. Yes, the 7820X looks expensive in terms of pure core count, when you can grab an AMD eight-core CPU for half the money, but there's more to CPU performance than mere core count. Intel's cores remain the best you can buy on a per-core basis, and that,

combined with healthy clock speeds, means the Core i7-7820X is quicker than any current eight-core AMD processor.

That goes some way to justifying the price. Whether it gets you over the line and makes the 7820X a completely compelling proposition will come down to your usage scenario. If all you care about, for instance, is video encoding, this chip probably isn't for you. But as an all-round workhorse, it's a seriously nice CPU.

■ Jeremy Laird

LABS BENCHMARK RESULTS



Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Fantastic all-round performance; unlocked multiplier for easy overclocking.





PROCESSOR

\$149 | WWW.AMD.COM

AMD Ryzen 3 1200

Ryzen goes even lower-priced with an exceptional-value entry-level option.

While Intel may continue to dominate when it comes to instructions-per-cycle CPU performance efficiency, there's no denying that AMD's now the go-to when it comes to multi-threading – and with the Ryzen 3 1200, that's now clear from the bottom of the CPU market right through to the top. This new entry-level chip also nicely highlights the overall value engrained in the AMD AM4 platform, even at this lower-tier in the CPU market.

We tested the new 1200 using our standard AM4 testbed, based around ASUS's RoG Crosshair VI Hero, which packs an AM4 X370 chipset. While that is a compatible setup, it's the concept of pairing the Ryzen 3 1200 with a cheaper B350 based AM4 motherboard that really appeals. (The Gigabyte AB350-Gaming 3, MSI B350 Tomahawk or ASRock Fatal1ty AB350 Gaming K4 are all B350 based motherboards that

have been awarded APC Recommends awards.) With the ability to overclock the CPU and RAM on these platforms, there's a significant value offering that, on the Intel side of the fence, would require higher expenditure to get the equivalent configuration versatility.

Driving that point home further, to build a similarly overclockable platform from Intel, you'll be paying a \$100 premium to get an entry-level Z270 motherboard paired with a Core i3-7350K. Admittedly, we're still big fans of the Intel setup as it significantly lowers the cost of entry for an overclockable Intel platform, and with the right cooling it can reach impressive clock speeds. However, the arrival of the Ryzen 3 1200 has severely dampened the hype on the Core i3-7350K, even on its locked, non-overclockable brethren, the Core i3-7100 and i3-7300. Moreover, many entry-level Z270 motherboards are not

appropriately specced for heavy overclocking, with lower phase-count VRM solutions, whereas we've proven in the APC labs that the AMD B350 solutions are primed and ready to handle even the 8-core, 16-thread Ryzen 7 1800X, making the Ryzen 3 1200 an easy chip to drive above its stock spec.

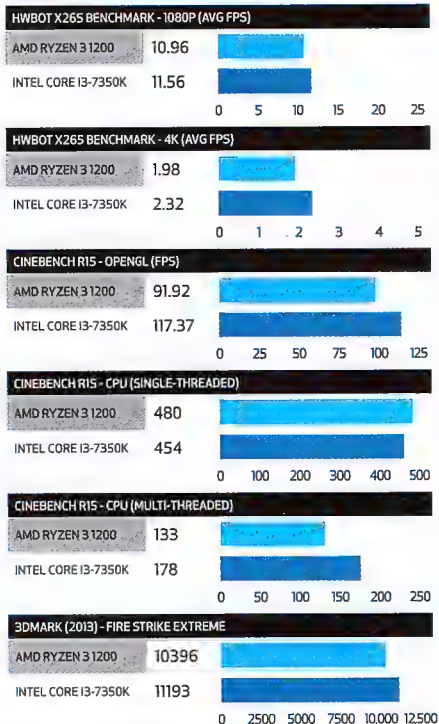
Let's take a closer look at the performance details. The Ryzen 3 1200 features stock frequencies of 3.1GHz base clock and 3.4GHz boost clock across four cores with four threads. This delivers reasonable performance in single-threaded workloads near Intel's alternatives, alongside particularly strong multi-threaded performance. But it's exploring the frequency boundaries that rewards significant performance gain. In testing we could easily push the CPU to 3.7GHz across all four cores. Beyond this point, there appeared to be an architectural or platform hard limit, as even setting a 37.25x multiplier for a

frequency of 3.725GHz forced a hard-default outcome of 1.5GHz operational frequency. It's disappointing that the little chip couldn't go further, but even at 3.7GHz the performance gains were significant, demonstrating up to an additional 17% in benchmarks.

The Ryzen 3 1200 has proven to be the little chip that can. With the initial AM4 platform teething resolved and a price of \$330 for an overclockable CPU and motherboard combo, this is an exceptional-value offering for those who need multi-threading on a budget.

Josh Collins

LABS BENCHMARK RESULTS



Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

An excellent value CPU that provides solid overclocking on a budget.





PC CASE

\$150 | WWW.FRACTAL-DESIGN.COM

Fractal Design Meshify C

An excellent budget PC case with not-so-tiny tempered glass.

The case has a simple job: house the other PC components and look good while doing it. Keeping things cool, quiet, and dust-free is important, too, but compared to the bazillion floating-point calculations your graphics card has to do, it's an easy life. Yet picking a model that checks all these boxes is never as easy as you'd first imagine, given the various options available — quiet cases or cases with great cooling options; budget cases or cases that don't tear your hands to ribbons when you build in them.

Fractal's Meshify C forces no such compromise on you in exchange for its \$150. The all-mesh front panel sets the case up for a clear airflow and the tempered glass side panel offers a high-quality aesthetic. Inside, a PSU shroud and excellent cable management options double down on those existing visual and airflow strengths, along with nice touches such as

a bracket behind the motherboard where up to three SSDs can be mounted. These can also be removed during a build to allow easy access to the motherboard's rear when fitting a CPU cooler — a real blessing, because fitting coolers is often the most arduous part of a build.

The enclosure at the Meshify's base also houses storage bays, and although it's always preferable to use a modular PSU in this type of setup, in order to make life easier when it comes to cable management (not to mention getting the rear panel back on the thing), we were able to fit a non-modular PSU, with ample room to store the unused cables between the unit itself and the storage bays. The internal panel on which the motherboard is fitted also features three handy cutaways at the base through which connections at the bottom of the motherboard, such as HD audio and USB headers, can be kept neat and tidy, too.

The side cutaways are fitted with rubber grommets and are slightly angled, which enabled us to make those connections to the GPU that bit more easily.

Despite housing ATX, mATX, and ITX systems, this case runs shorter along its length than most mid-tower models. We like the visual effect of that, and the space-saving, but it does mean that three-fan graphics cards are a really tight fit. Fractal's spec sheet states 12.4 inches of clearance for GPUs and, true enough, we could install our 12-inch Radeon HD 6990, but it was a cigarette paper's width away from the supplied Dynamix X2 GP-12 120mm front fan. There's always the option of removing that fan, but it's something to be aware of if you're packing an oversized chunk of PCB on graphics duty. There are seven fan mounts throughout the case, and room for radiators at the front and top, with dust filters placed here and below the PSU. Bonus points are

awarded for a front removal mechanism for the bottom filter — no need to move the whole machine to access it.

The only obvious concessions to its \$150 pricing come in the top panel magnetic dust filter, which isn't very closely fitted to its inlay and looks noticeably cheaper than the rest of the case, and a flimsy front panel, which has a bit too much give to instill any confidence. That's literally it: two tiny grumbles about an otherwise exemplary case with features you'd expect from a much pricier model. Meshify, it was a pleasure to build in you.

■ Phil Iwaniuk

Verdict

Features
Performance
Value



Great airflow; easy cable management; classy window.



software

» APPS FOR ALL THE PLATFORMS



Windows SOFTWARE

Screenshot Captor

Give your Print Screen key a serious upgrade.

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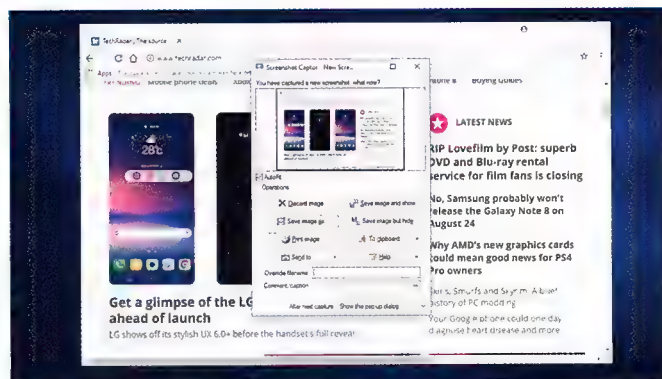
Screenshot Captor, from DonationCoder, is just about the most powerful free screen capture tool you can download. It's thoughtfully designed and packed with options that will make your life easier, whatever you need screen grabs for.

Although it's available as both installable and portable versions for Windows XP and later, currently there's nothing available for Mac or Linux, so this is a Windows exclusive.

It lets you capture your whole screen, a selected area, an individual window, or even the content from a scrolling window – a feature you won't find in any other free screen capture software. Screenshot Captor can even capture stills from your webcam, or import images directly from your scanner.

If all that isn't enough, you can also import images from your scanner directly into Screenshot Captor's image editor, neatly bypassing several steps that would normally be necessary for tasks like importing and annotating contracts.

Once installed, Screenshot Captor appears as an icon in your system tray and a desktop widget. You can either use this to choose a capture option, or use a customisable keyboard shortcut.



Screenshot Captor's toolkit includes options for blacking out sensitive information like passwords and usernames, and highlighting important areas. There's a comprehensive set of watermarking tools, plus all the brush, text, selection and shape tools you'd expect from a basic photo editor.

Before you can install and use Screenshot Captor, you need to request a free six-month key from the developer or generate your own three-month key. This system is designed to encourage users to consider making a donation, but if you can hold out for 12 months you'll be able to generate one for free.

This screen capture software is extremely impressive, though users may want to be mindful that making a donation gives "guaranteed lifetime to site content with no recurring charges ever, regardless of any future changes to site policy", implying that Screenshot Captor may not be free for personal use indefinitely if voluntary contributions aren't enough to sustain it.

Cat Ellis

Spritzlet

Read fast if you're curious

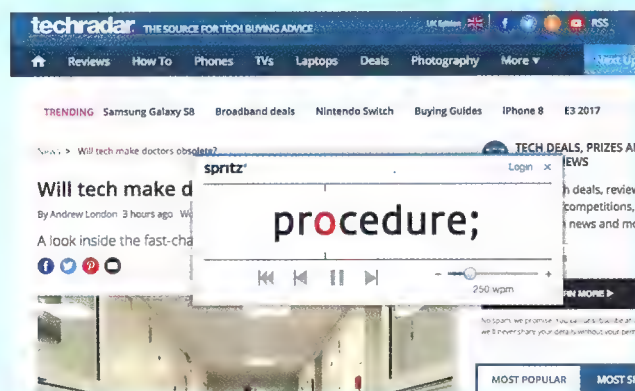
FREE | WWW.SPRITZINC.COM



This little browser extension slashes the time it takes to read text on a screen by displaying words one at a time in quick succession (a technique known as Rapid Serial Visual Presentation) so you can absorb them without moving your eyes. Its developers claim that with a little practice, it can help you read as many as 1,000 words per minute.

The Spritzlet extension is designed for desktop and mobile browsers, and works with Chrome, Safari, Firefox, Opera and Internet Explorer. Just drag the button into your bookmarks bar to install it.

There's a slider to adjust the speed, and a pause button if you need to take a break to process what you've just read. If you only want to read part of a page, select the text before pressing the button.



Registering for a free account lets you read at speeds below 200wpm or above 450wpm, and lets you save your preferences as you move between sites, but it's not essential.

Cat Ellis



Boom 3D

Make your Mac sound better.

\$19.99 | GLOBALDELIGHT.CO



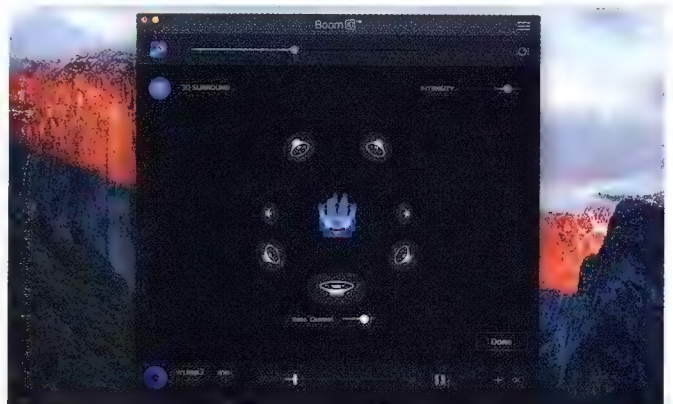
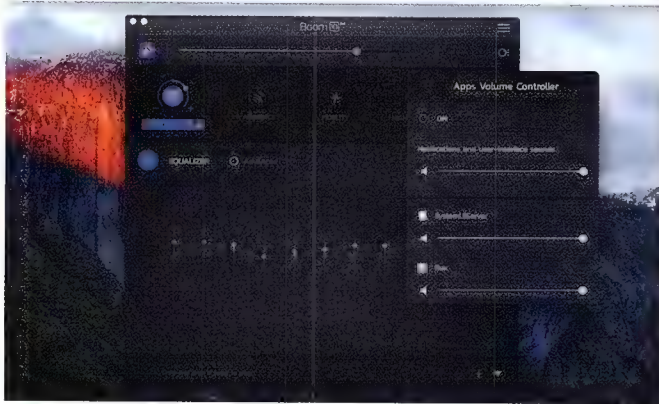
There's a problem with ever-thinner Macs: thin cases mean thin speakers, which means thin sound. It's particularly noticeable on the iMac, on which music sounds as if it's being shouted at you by somebody in a bucket, but it's a problem on MacBooks, too. Boom 3D can help.

The app changes the sound of your Mac to make it brighter, wider — and on headphones, to give you virtual surround sound. It works: turning it off makes the sound considerably duller and less interesting. At heart, it's an equaliser with some extra effects to add 'air' at the top end, widen the stereo

image and so on, but it's packaged in a way that people who aren't audio experts can understand.

It's particularly good on headphones, with wider stereo, better bass, and more pronounced separation of individual sounds such as gunshots and vehicles. It's easy to overcook the sound — crank up the sliders and the sibilantsssss sssssound like ssssssnakesss — but if you take a 'less is more' approach it's very effective. It's no substitute for good quality speakers, of course, but it's a big improvement.

Boom 3D really can make your Mac sound better, especially with headphones. **Gary Marshall**



Switchem

Group your apps into workspaces.

US\$10.99 | SWITCHEM.CO



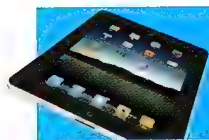
Window management is something of a holy grail on the Mac. The operating system includes Spaces for organising windows across multiple desktops, but the feature lacks granular control.

Switchem takes a different tack: it lets you set up multiple grouped app workspaces for different tasks and flip between them using a mechanism similar to macOS's built-in app switcher. Once you've organised all your task-related app windows, simply create a new group, give it a name and Switchem assigns a number to the workspace. You can then switch to it at any time using a 'Command-Tab-[number]' shortcut, which brings all apps to the front in their original positions.

The solution works well on single desktops, while additional handy shortcuts make opening and closing all apps within a group a cinch. It's just a shame Switchem doesn't support full-screen apps — also designated Spaces by macOS — across multiple displays, although the developer has promised compatibility in a future update.

It's good for defining multiple workspaces on a single desktop. **Tim Hardwick**





App Store » iOS APPS

Qlone

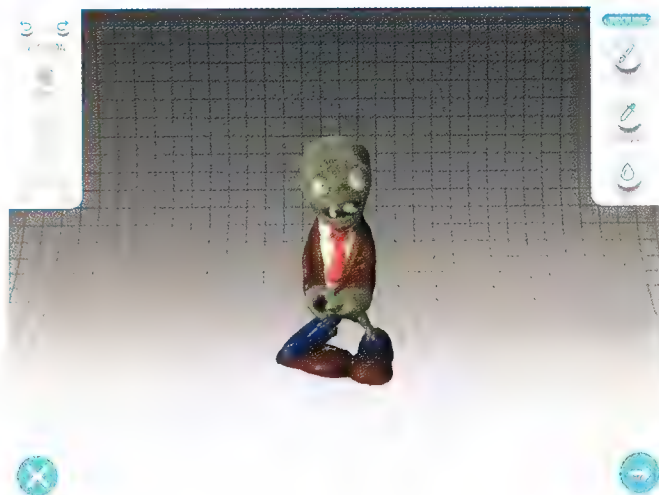
Scan 3D objects with your camera.

FREE WITH IAP | QLONE.PRO

 Qlone is a 3D object scanner that uses your iPhone or iPad's camera to capture, edit, and export a 3D model. Scanning objects is free, and so is editing and sharing a static JPEG or GIF. But if you want to use the models in other projects or print them with a 3D printer, exporting in OBJ, STL, PLY, and X3D format will cost you. Qlone sells credits as in-app purchases.

First, you have to print a mat with a black-and-white grid. Letter-sized paper is fine for small objects, and you can print on larger paper to scan bigger things. Regular room light resulted in messy scans, but when we added a desk lamp, the quality improved.

When scanning, an augmented reality dome appears over the object, and you have to move the camera over every section of the dome. This requires slowly rotating the mat or physically walking around the table, crouching to get every angle, which can take a while. We got better results by tipping the object on its side and doing a second scan — the app can combine two scans of the same object.



Processing is shockingly quick. Even with good lighting and careful two-pass scanning, our results were hit or miss. A Lego truck and Hot Wheels car came out muddled, but simple vinyl figurines fared better. The editing tools let you smooth out lumps, erase extra bits, change textures and more. But we never got anything we'd be excited about printing in 3D. It's fun to play with, but needs effort. **Susie Ochs**

BrainPOP

The more you know, the more you know!

FREE WITH IAP | WWW.BRAINPOP.COM



This app is aimed at children, yes, but the messages it conveys are invaluable to big kids, too, like you and me. Each day, the app features a video that aims to teach you something — such as, what is an eclipse, how should we act online, how do compasses work, what is information privacy, how to deal with bullying, learning about continents, how to make friends, how to prepare for school exams and even some history topics. Each video is a colourful cartoon, featuring friendly characters (or not so friendly, in the case of the bullying and slavery videos...) but, above all, important messages to take away. Today's video was about goals and the ways in which you can achieve them. Instead of simply preaching 'this is what you should do in order to achieve success', the video presenter gave your humble reviewer a few different options, explaining that certain things work better for some people, but not all, and that if one thing doesn't work, it's OK to try another route to your goal. After each video, you can watch it again or be quizzed on what you remember. If you log in, you can save videos and compare your scores with friends, as well as play educational games, try your hand at some science, English or maths activities (or 'math', since this is a US-made app). As an arm of the extensive online hub, it does pretty well to not appear too cluttered in design and usability — but there is a lot of content to be had here. It also has a lot of content for teachers, too, including lesson plans. **Carmel Sealey**

Readdle Documents 6

One app for any file and any cloud.

FREE | READDLE.COM



Documents 6 is a great app with terrible timing. In iOS 11, Apple will roll out Files, a reimagining of the iCloud Drive app that also supports other cloud services. That's the same as Documents, but Readdle's app goes even further. You can download files from the web via a speedy built-in browser, add them directly to Documents from iTunes, or choose 'Copy to Documents' from the share sheet throughout iOS. Then it's easy to view files, move them, or even zip a folder into an archive to send. Readdle even nailed drag-and-drop on the iPad before it's added to iOS 11. You can drag a file between Documents on one half of an iPad screen and another Readdle app (Spark, Scanner Pro, or PDF Expert) on the other half. It works seamlessly.

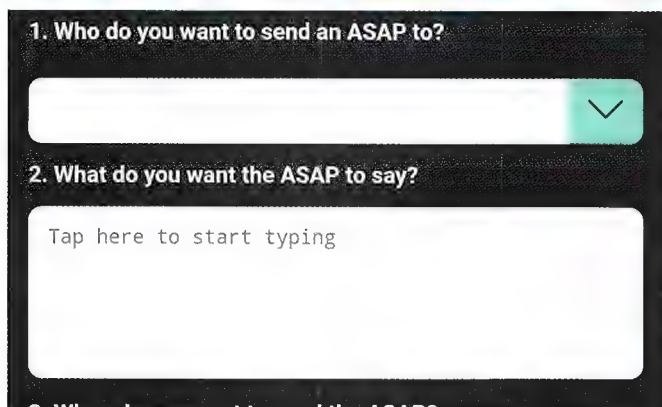
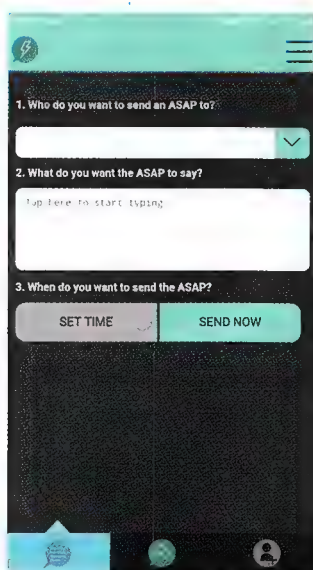
Even with iOS 11 around the corner, Documents is worth having for its flexibility. You can listen to music stored in your iTunes library or streamed from the cloud, plus watch video files that Apple's player doesn't support. You can connect to a WebDAV, SFTP, or FTP server, not to mention Dropbox, Box, SharePoint, OneDrive, Google Drive, Windows SMB and Yandex.Disk.

The app's main drawback is that some of its abilities depend on other Readdle apps — if you try to mark up or sign a PDF, you're prompted to install the \$15 PDF Expert first. But you can always send files to other apps (such as Notes, in the case of that PDF) to finish a task.

Grabbing Documents 6 is key if you've got files in multiple clouds. **Susie Ochs**



Google Play » ANDROID



ReplyASAP

Making chat easy.

FROM \$1.49 | REPLYASAP.CO.UK

 ReplyASAP sends text messages to recipients and ensures that they're alerted to it, even if their phone is on silent. It's ideal for parents who want their children to acknowledge a text — and reply — or for anyone who simply wants to check in with a friend, or family member, or who needs someone to check in on them. The point of it is that your text message doesn't go unanswered or ignored, as the app (which must be installed on both the sender and receiver's phones) creates a wailing noise whenever a text is received, and needs them to either snooze it or reply. It's either as obnoxious or perfect as you see fit. The sender downloads the app, sends a recipient a referral code to get the app themselves, and then the sender pays for usage. It's free for the recipient. Various bundles allow for multiple recipients. It's far from perfect: we had trouble setting it up, and your recipient must have internet access. They can also just delete the app, though you will be notified of this. **Paul Taylor**

JotterPad

Word processing without the clutter.

FREE WITH IAP | 2APPSTUDIO.COM/JOTTERPAD



JotterPad has been designed for authors, whether you're writing a novel or a screenplay, poem or essay, with its clear, crisp layout and handy formatting tools. It's especially handy for screenwriters, as JotterPad offers shortcuts to paste in oft repeated locations and characters, rather than having to type out each one — which can get repetitive in a rapid-fire conversation. Autofill helps the process here; an intelligent feature. There's also a variety of screen modes for editing and reading, so you can get your screenplay in front of your crew in the format they're used to. If a word comes to mind and you want to check its meaning, an instant dictionary search pulls up results from Wordnet, Big Word and Glosbe, a trio of dictionaries and thesauruses. That latter feature comes free, but the powerful screenplay tools have to be paid for — a not-insignificant \$20.99. With your wallet firmly in your pocket, you get an uncluttered, minimalist word processor, but one that pales in comparison to Google Docs. **Paul Taylor**

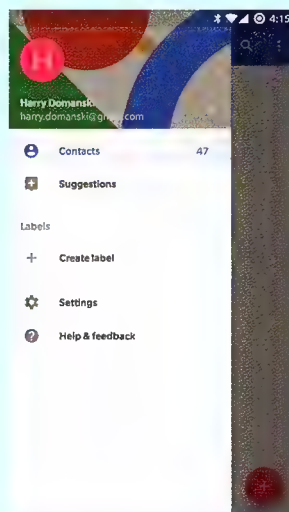
Google Contacts

Google finally shares its simple and clean contacts manager.

FREE | TINYURL.COM/TLA69-CONTACTS



If you're an avid user of the Google/Android ecosystem but don't actually own a Nexus or Pixel smartphone, you'll be pleased to know that Google's Contacts app is — finally — officially available to every other Android device out there (well, provided they're running Android 5.0 or newer). Alongside this compatibility 'fix', the app has been updated with the ability to merge duplicated contacts and to receive automatic suggestions for info to add to existing contacts, both very useful features for simplifying the often-daunting list that contacts can become. Of course, you'll be getting everything that typically arrives with a contacts app, but naturally, you'll also get Google's integrated sheen along with it. The ability to save all your contacts to a Google account, in particular, is handy for people who switch phones often or work across numerous devices, and being able to add contacts to groups is plenty useful for separating such things as work and 'real life'. You can input an alarming amount of detail for each contact too, even including things like how to phonetically pronounce their first and last names. **Harry Domanski**





Green-recorder

The screen recorder.

FREE | [GITHUB.COM/FOSS-PROJECT](https://github.com/fooss-project)

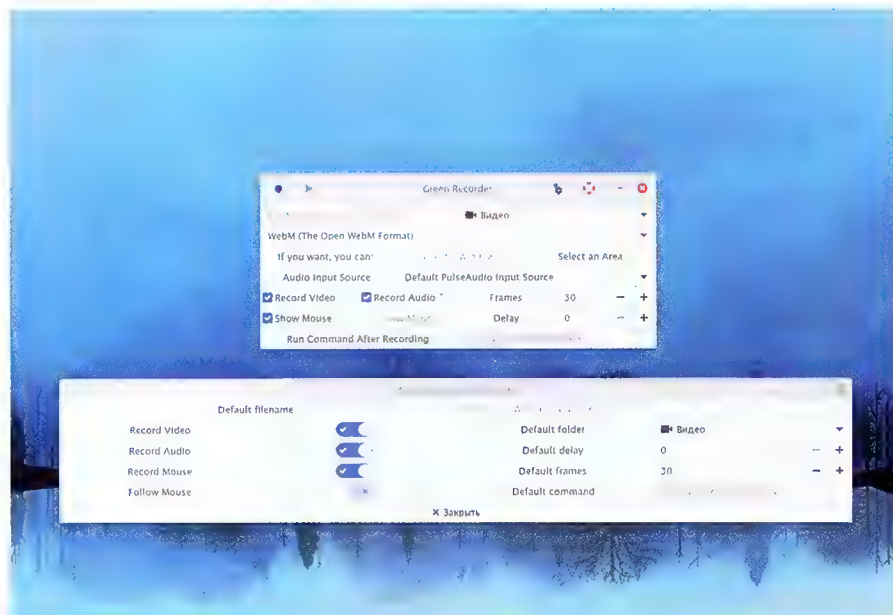
We're not sure whether Canonical is brave enough to boot the upcoming Ubuntu 17.10 to Wayland by default (looks like it is), but other major distros, such as Fedora, ship Gnome desktops that silently boot to a Wayland session instead of X.org. We really love Wayland as a cool next-gen technology, but it's still not mature enough in some regards. One of its shortcomings was its inability to record a screencast, which now seems to be fixed. Meet Green-recorder, a small, stylish GTK3 app that's ideal for recording videos of what's happening on your desktop, and the first recorder that works in a Wayland session out of the box.

Green-recorder is based on Python, GTK3 and FFmpeg, and thus supports many video formats, including MKV, AVI, MP4, WMV, GIF and more. When used with Wayland, Green-recorder can only write video using the WebM format and compress the data using the V8 encoder, instead

of the more recent V9. That's the price you pay for Wayland right now, but we think it's not too high. Green-recorder captures video data using the built-in screencast feature in Gnome Shell and records audio using FFmpeg, then merges both tracks into a single WebM file. The application also produces very nice GIF outputs. We compared GIF recordings made using pure FFmpeg and Green-recorder, and admitted that the latter was far smoother – that's because Green-recorder makes GIFs out of the raw uncompressed video data.

Although the Green-recorder interface is very simple, it gives you all the necessary features right at your fingertips, and enables you to set up frame rate, destination directory, file format and audio input source, and even execute custom commands after the recording is finished.

The Green-recorder developer advertises pre-built packages for various Linux distributions, so in most cases, you only need to worry about copying and pasting the necessary lines from the Readme.md document. **Alexander Tolstoy**



Qmmp

A multimedia player with a soft spot for the good old times.

FREE | [QMMP.YLSOFTWARE.COM](https://qmmp.ylsoftware.com)

This one is a nostalgic choice for anyone who remembers Winamp and its 'llamas' welcome sound. However, in every other regard, Qmmp is a modern multimedia player that continues to receive frequent updates, enhancements and fixes. We think it attracts a noticeable number of people who want to have a simple player with a playlist and all the frequently used controls fit inside its small main window. Qmmp looks very similar to Winamp, and given the fact that it supports all of the uncountable numbers of WSZ skins ever created for Winamp 2.x, you can make it look identical to the prototype.

Qmmp was made with the idea that you may want to organise your music with a file manager and browse albums as folders, without keeping a separate library (which is commonly a SQLite database in most other players). Having said that, all you need to do is drag a selection of files or folders on to the player's window and watch them be added to the playlist. By default, the Qmmp window consists of three parts: the player itself, the equaliser

and the playlist. All three stick to each other like magnets, but you can still detach the equaliser and playlist, rearrange them or keep them completely separate.

The player is a versatile multimedia machine, thanks to the bundled set of plugins. Most desktop environments associate Qmmp with audio files, whereas the player can open video files just fine. For that, Qmmp uses FFmpeg and Mplayer plugins, but it also supports mpg123, gme, Wasapi and more.

For instance, using gme (which stands for 'game'), you can play games such as Super Mario for Game Boy right inside the Qmmp player. Looks as though we have an application for everything, which means you can get rid of other media players — if you like the approach and style of Qmmp.

The player should already be available in your package manager, so no need to deal with sources (unless you need bleeding edge code).

Alexander Tolstoy



PC GAMING ANNUAL

**SPECIAL ISSUE: THE BEST GAMING GEAR ON TEST —
MONITORS, MICE, KEYBOARDS & HEADSETS FOR EVERY BUDGET!**

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Graphics card buyer's guide

Confused by all the GPU options currently on the market? The APC team makes choosing the right one simple with this comprehensive and (mostly) jargon-free guide.

With both AMD and Nvidia both relying on GPU designs launched over a year ago at this point, we're about due for a refresh at the top end. That doesn't mean now's not a good time to buy a new GPU, however – especially if you're aiming for the competitive budget or mid-range space. High launch prices have well and truly subsided, so there are some genuine midrange bargains to be had in particular.

There are more formats and resolutions than ever before for PC gaming – the proliferation of ultra-widescreen displays means it's no longer just 1080p, 1440p and 4K. You've now got newfangled ultrawide 21:9 aspect-ratio models (which are commonly either 2,560 x 1,080 pixels or 3,440 x 1,440 pixels) that demand more GPU grunt, not to mention the burgeoning VR market.

HOW FAST IS FAST ENOUGH?

With any graphics card purchase, your ultimate goal should be to maintain an average framerate above 60fps in mainstream games, and you really don't want that number dropping below 30fps at any time – doing so means you'll really start to feel the slowdown in the gameplay and it makes for a frankly crappy gaming experience.

With the bulk of PC monitors still 1080p models – or 1,920 x 1,080 pixels – for most of us, a high-end graphics card like the GeForce GTX 1080 Ti is overkill. You can get much better bang-for-buck at the \$300–\$400 mark, but you don't even need to spend that much to get solid speeds at 1080p. On the other hand, when paired with a high refresh-rate monitor,

higher framerates can arguably improve the overall experience, making games feel faster and more responsive – and you mightn't need to spend a fortune to get on board this revolution, with HFR monitors starting at \$200.

WHEN TO UPGRADE

To keep on top of modern graphics upgrades, most PC gamers will want to upgrade their GPU every two to three years. Driver upgrades tend to eke more performance out of cards over time, but these can only go so far.

When exactly you should upgrade is going to vary significantly from person to person, but the general rule is that, if your current setup can no longer maintain 60 fps at Medium detail settings, it's worth investigating the current GPU scene.

IS OVERCLOCKED WORTH IT?

This is really a question of how much you're being asked to pay. While higher clocks does indeed generally mean more FPS, out of the factory, most overclocked cards only offer a modest speed increase in the range of 2–5%. What you're really paying for is the chance of achieving higher speeds manually thanks to better cooling hardware and higher-quality power components.

That said, you'll be lucky to eke more than about 10–15% of an increase from most GPUs and their accompanying memory – remember that both need to be bumped up to see a consistent increase in framerates. Generally, then, you shouldn't pay more than 15% more for an overclocked card.



\$210 | WWW.NVIDIA.COM

BEST BUDGET OPTION (AROUND \$200)

Nvidia GeForce GTX 1050 Ti

1080p at 60fps for next to nix.

This price point is about as low as you can go and still get a 'real' gaming GPU.

For budget gamers, what you're aiming for at this price is a card that can average around 60fps at 1080p in modern games, and you can generally get that with the 1050 Ti, provided you turn the detail settings down to Medium/Normal.

This end of the market is surprisingly competitive, with a few cards hovering around the \$200 price point that are worth considering, including AMD's Radeon RX 560 – recently launched, and largely based on the RX 460 from mid-2016, but with 15% more cores and slightly faster clock speeds. Nvidia's budget cards (the GTX 1050 and 1050 Ti) are from late-2016, so they're also getting long in the tooth.

Ultimately, though, if you have \$200 to spend, you want to spend all of it. The RX 560 is selling for around \$160 to \$170 on the street – it isn't too bad a card, and it's

essentially neck and neck with the GTX 1050 on bang-for-buck. But spend an extra \$30–\$40 and you'll be able to pick up a card that's about 20–25% faster – the 1050 Ti. Like the GTX 1050, it's based on Nvidia's most recent Pascal architecture, so they're cut from good stock. However, they're also cut down quite deeply. At around \$170, the slower GTX 1050 proves to be quite good bang-for-buck if you're looking strictly at 1080p performance in current games, but its 2GB of VRAM is going to find it hitting a wall sooner rather than later. The 1050 Ti doubles that to 4GB, and it's about 15–20% faster overall. That makes it a good deal more futureproof – and, in our book, worth the extra cost.

Verdict

While there are cheaper options out there, this one takes home the gold for all-round value.



\$350 | WWW.AMD.COM

BEST LOWER-MIDRANGE (AROUND \$300)

AMD Radeon RX 570

AMD's current refreshed all-rounder.

The current cryptocurrency mining craze has driven up demand for GPUs around this price, which, in turn, has bumped a lot of prices up 10–15% from what they were 6 months ago. As such, the closest card to \$300 that we're willing to recommend is AMD's Radeon RX 570, which starts at around \$340. As with the RX 560, the 570 is a tweaked version of its 2016 predecessor, the RX 470, and in many games, it's only about 5% faster.

The 470 was essentially a slightly cut-down version of the RX 480, and it's the same formula with the 570 and 580 – that makes this a comfortable 1080p/Ultra card – it's able to clear most modern games at 60fps with those settings, and it can even stretch to 1440p in many titles at Medium details. While some 470s could get away with a 6-pin power connector, the slightly higher clocks used on the 570s means they

almost universally require an 8-pin connection – you'll need a 550W PSU to support one comfortably. On a frames-per-dollar metric, the RX 570 stacks up very well – it's third from the top on our overall list.

That said, eagle-eyed readers will note that the GTX 1060 3GB is about 1% better in the FPS-value stakes, and it's around \$10 cheaper to buy. So why are we recommending the RX 570 over it? Well, 1% is a 'margin of error' kind of difference and, moreover, the RX 570 has an extra gigabyte of RAM, which should theoretically allow it to stay competitive at 1080p/Ultra settings for a little bit longer, so it's slightly more futureproof.

Verdict

In a tough cryptocurrency-mining inflated price climate, this card gets the begrudging nudge from us.





FROM \$400 | WWW.NVIDIA.COM

BEST UPPER-MIDRANGE (AROUND \$400)

Nvidia GeForce GTX 1060 (6GB)

Room to expand.

Creeping up to around \$400 will net you a card that can do 1080p with absolutely all the bells and whistles turned on and cranked up, and also offer some breathing room to keep that up in any future titles that prove to be a bit more demanding. Alternatively, if you're using a higher-definition 1440p screen or a 27-inch ultrawide, spending this much on a GPU should generally let you play at High detail settings.

In this space, you've basically got two \$400 cards going head to head – the Radeon RX 580 with 4GB of memory, and the GeForce GTX 1060 with 6GB of RAM. While there's also an 8GB version of the RX 580, it doesn't actually complicate things: at \$450–\$480, it's 10–20% more expensive, but in most current games, it doesn't improve framerates more than a percent or two over the 4GB edition. In other words, paired with this mid-range GPU,

doubling the memory is not quite worth the extra \$30.

Coming back to that main contest, then, it's often a very close competition, but the 1060 pulled ahead enough to crack a slight lead across our 15-game suite at 1080p. They were basically even at 1440p, and at 4K, the RX 580 was actually 2% faster – but neither card can actually produce playable framerates at that high a resolution setting.

Don't count on getting too much of AMD's historical 'speed increases via driver updates' either – like the RX 570 on the previous page, the 580 is really a tweaked RX 480 in disguise.

While the 4GB RX 580 delivers OK value, it's been slightly outcompeted by the GTX 1060 at this price.

Verdict

Gets its nose ahead of AMD's Radeon RX 580 in the race for the crown.



FROM \$600 | WWW.NVIDIA.COM

BEST PREMIUM (AROUND \$600)

Nvidia GeForce GTX 1070

For VR and (a fair bit) beyond.

We're getting up into the big leagues at this price point and, to be completely honest, it's probably overkill to spend this much on a graphics card if you're only gaming at 1080p – unless you want to take advantage of high-framerate techs like G-Sync and FreeSync.

If you've got a higher-res monitor, you'll be able to achieve very comfortable 1440p/Ultra gaming at this price, and you can often even manage 4K resolution at Medium detail settings. This is also the kind of card you'll need to aim for if you're buying one of the new 32-inch, 3,440 x 1,440 ultrawide displays.

This price point has been a bit of a one-horse race for much of 2016 and 2017, with AMD not really having anything that can compete with the GTX 1070. That changed recently with the launch of the Radeon RX Vega 56, a \$650 card that, in most tests, is neck and neck against that GTX 1070.

The real key here is price. With 1070s starting at \$600 (the cheapest Vega 56s start at \$650), the Nvidia card becomes our defacto choice – even though it's a full year older. When the Vega 56 comes down in price – once the initial supply shortfall and cryptocurrency miner demand tapers off – then it will be the better long-term choice. But by then, Nvidia may well have its 2000-series (or whatever it ends up calling them) GeForce cards to market...

It's also a bit more economical in terms of power use – around 15–20% at peak. There is one use case where we'd favour the Vega 56, however, and that's if you're planning on pairing it with a FreeSync monitor.

Verdict

With AMD's Vega 56 prices suffering due to demand, it's a bit of a no brainer to grab this instead.





FROM \$1,100 | WWW.NVIDIA.COM

THE 'MONEY IS NO OBJECT' CHOICE

Nvidia GeForce GTX 1080 Ti

4K and HFR, here we come!

If you're looking to blow the budget on a top-level card, you can't really put a foot wrong with the GeForce GTX 1080 Ti. AMD's recently-released Vega graphics cards are aimed at the GTX 1070 and 1080, respectively, so for now, there's nothing from the red team that that can compete against Nvidia's latest Ti flagship, with AMD seemingly content to focus on the midrange and entry-level markets until at least 2018.

However, given the 1080 Ti is a whopping \$500 more than the 1070 and around \$300 more than a standard 1080, the question becomes one of how excessive you want to get. In other words, should you go for a single 1080 Ti for around \$1,100, or opt for a pair of GTX 1070s for about \$100 more?

If you're gaming at 4K or on a larger ultrawide, a single overclocked GTX 1080 Ti can net you a 60fps average in most games – across our 15-title suite, our 4K average was 65fps, while

a pair of 1070s in SLI was 75fps. At lower resolutions, the higher clockspeeds of a single 1080 Ti actually turns out higher average framerates. There are still lots of caveats with SLI, like the need for a beefier PSU (although an 850W will be ample of two 1070s), game support isn't universal and, moreover, that SLI tech still doesn't work with VR. You'll also want to pick up an HB bridge, for around \$60, to ensure the best SLI performance.

Unless you're running a 4K or multi-monitor setup, then, the GTX 1080 Ti is the safer, simpler bet – and the one we'd recommend for most setups. If you do go the SLI route, be prepared to have to tinker and troubleshoot.

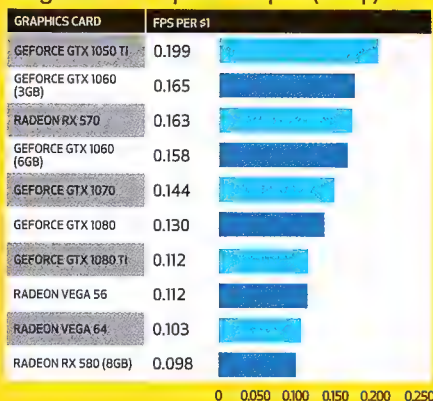
Verdict

If you've got cash to burn, the best option in this category is also the most reliable.

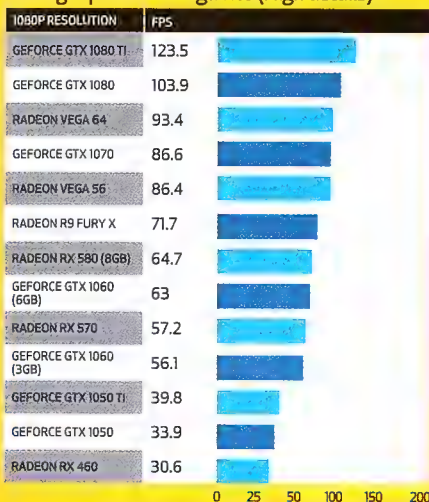


LABS BENCHMARK RESULTS

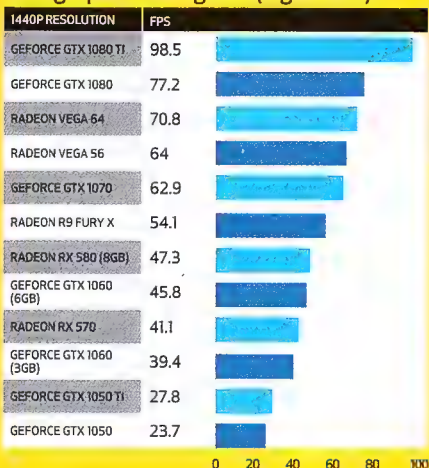
Bang for buck: FPS per dollar spent (1080p)



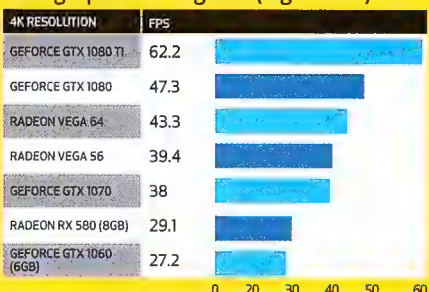
Average fps across 15 games (High details)



Average fps across 15 games (High details)



Average fps across 15 games (High details)





\$999 | WWW.ACER.COM.AU

Panel: 27-inch TN; Resolution: 1,920 x 1,080;
Refresh rate: 240Hz with Nvidia G-Sync

Show me where it hertz

A gaming monitor is today's most essential upgrade after a good mouse and keyboard. Lindsay Handmer tests 11 screens tuned for gaming greatness.

It used to be that there were normal monitors and gaming monitors, and not much else. But these days, there are a huge range of models that target everything from esports, to different game styles and even GPU brands. Increasingly popular are monitors with high refresh rates, which allow your screen to actually display more than 60fps. While many new games are very taxing, powerful (and even midrange) GPUs can often manage quite high refresh rates. Typically, some sort of adaptive sync technology is needed, to avoid a mismatch between the frame rate and refresh rate, which can cause frame tearing and stuttering.

The minimum resolution nowadays is 1,920 x 1,080, though 2,560 x 1,440 and even 3,840 x 2,160 are increasingly popular. In fact, 2,560 x 1,440 on a 27-inch monitor is a nice mix between high-quality visuals, and not overtaxing your (still high-end) GPU. The better (and more expensive) screens all use IPS panels for high-quality visuals. But TN screens are still faster (and more affordable), so tend to dominate the lower budgets, or models pushing the limits. There is also a wide range of monitors that attempt to bridge the gap between work and play, with great specs for casual gaming, but also features needed for productivity.

Higher-end gaming monitors (especially those using Nvidia's G-Sync) don't come cheap. On the plus side, they incorporate all sorts of handy features, such as stands with height adjustment and the ability to pivot 90° and USB hubs.

HOW WE TESTED

Each monitor was tested on a high-end gaming PC, running either an AMD or Nvidia GPU for testing both FreeSync and G-Sync. Connection was via DisplayPort or, where not available, HDMI. Each monitor was tested with a variety of games including *Ashes of the Singularity*, *League of Legends*, *Elite Dangerous*, *Starcraft II*, *Doom* and *GTA V*.

Acer Predator XB272

For when every frame counts.

While many gaming monitors offer 144Hz, the Acer Predator XB272 blasts through that with a massive 240Hz. Of course, to get there, it needs to make some trade-offs – for good and for bad.

For a start, despite the large 27-inch size, the XB272 sports a 1,920 x 1,080 resolution and a TN panel. That's by no means bad, but does mean the screen is focused on gaming, and day-to-day normal usage is not as pleasant as with a higher res, IPS screen. On the plus side, the Acer has a very low 1ms response time, and comes equipped with G-Sync.

As far as 1080p TN panels go, the Acer is great, with reasonable colour accuracy and viewing angles. It can be a little hard on the eyes for daily use, but isn't bad by any means. When it comes to high-speed gaming, though, the Acer really stands out.

A powerful Nvidia GPU is must-have, but the XB272 gives an incredibly fast yet smooth gaming experience that few other monitors can compete with.

The actual monitor itself has a tough and functional style, with extremely thin bezels well suited to multi-monitor gaming. The stand is also top notch, with height, tilt, pivot and swivel adjustment.

Aimed at niche gaming, the XB272 only has HDMI and DisplayPort inputs, but comes with both cables. It also has a 3.5mm output, plus a USB 3.0 connection with two ports on the rear, and another two on the side.

Verdict

Not ideal for most gamers, but a fantastic screen for those after G-Sync and 240Hz refresh rates.





\$899 | WWW.ACER.COM/AU

Panel: 27-inch IPS; Resolution: 2,560 x 1,440;
Refresh rate: 144Hz with Nvidia G-Sync

Acer Predator XB271HU

Image quality and speed combined.

Totally focused on gaming, the Acer XB271HU is \$899 of features squeezed into a very stylish red and black shell. The monitor measures in at 27-inch, and has a 2,560 x 1,440 resolution. The Acer uses an IPS panel for better image quality, but still has a decent 4ms response time. Its real party trick, however, is the 144Hz refresh rate, overclockable to 165Hz. Combined with Nvidia's G-Sync tech, the XB271HU is built for buttery smooth, high-end gaming.

The Acer is fantastic in everyday use, with bright, vibrant colours from the IPS screen and wide viewing angles. Some manual tweaking (especially reducing brightness) will help, but generally, it's quite well configured out of the box. The backlighting is very even, and the thin 2mm top and side bezels make it ideal for use in a multi-monitor setup. A high-end Nvidia GPU is a prerequisite,

but G-Sync gave us an entirely smooth, tearing- and stuttering-free gaming experience. While not at TN levels, the 4ms response time didn't show up any ghosting either. The OSD itself is fairly in-depth, though the control buttons can be a little awkward to use.

More than just a pretty face, the Acer is practical, and has a top notch stand with full height, pivot, tilt and rotation adjustment.

Round the back, it has DisplayPort and HDMI inputs, though only the former works with the 165Hz refresh rates and G-Sync. The monitor also has a 3.5mm output, and a USB 3.0 input, with two connections on the rear, and two on the side.

Verdict

Pricy, but offering excellent 144Hz gaming for those who want (and can afford) G-Sync.



\$689 | WWW.AOCMONITORAP.COM/AU

Panel: 27-inch TN; Resolution: 2,560 x 1,440;
Refresh rate: 144Hz with AMD FreeSync

AOC Agon AG271QX

Built for high-speed WQHD gaming.

First-person shooter lovers, rejoice, because the AOC AG271QX offers both a 144Hz refresh rate, and FreeSync technology. The monitor is built around a 27-inch TN panel, which has a 2,560 x 1,440 resolution and a fast 1ms response time.

The AG271QX will set you back \$689, but there is also a G-Sync-enabled version for \$899. The AOC AG271QG (note the G) version is different in a few ways. For a start, it has a slightly higher 165Hz refresh rate, but also uses an IPS panel, with a 5ms response time.

While the TN panel of the AG271QX can't keep up with its IPS competition, it still manages accurate, even colours, and minimal light bleed. Thanks to FreeSync, high-frame rate gaming with a AMD GPU is extremely smooth, with zero tearing or stuttering.

The viewing angles are fine for sitting straight on, and the 1ms response time ensured no ghosting.

The AOC has a range of gamer modes, including reduced input lag, and the ability to help lighten shadows. It also has a very handy USB connected desktop input switcher and OSD interface, which makes switching modes and tweaking settings easy.

The AG271QX has one of our favourite looking stands – slim, yet stylish and strong and with full height, pivot, tilt and swivel adjustments.

Round the back, the monitor has two HDMI, DisplayPorts, DVI, 3.5mm audio and USB 3.0, which includes fast charging. The screen also has a fold out headset hook, and reasonable 3W speakers built in.

Verdict

A strong collection of gaming features targeted towards those with AMD CPUs.



✓✓✓
apc
RECOMMENDS



\$1,099 | WWW.ASUS.COM/AU

Panel: 27-inch IPS; Resolution: 2,560 x 1,440;
Refresh rate: 165Hz with Nvidia G-Sync

ASUS RoG Swift PG279Q

A super-high-end gaming option.

Sure, spending more on a monitor than some do on an entire gaming PC might seem extravagant. But the ASUS RoG SWIFT PG279Q isn't just any rinky-dink monitor. Measuring in at 27-inch, it uses an IPS panel with a 2,560 x 1,440 resolution and 4ms response time. The PG279Q is also equipped with a high 165Hz refresh rate and Nvidia's G-Sync, to avoid stuttering or tearing when gaming.

Is testing, the monitor was more than happy to perform, and provided a smooth, seamless experience at extremely high framerates. Thanks to the IPS panel, the colours (100% sRGB colour gamut) are extremely good even when viewed off angle. The backlight is even with no noticeable light bleed, and the thin (6mm) bezels make it ideal for multi-monitor setups. You do need a beefy Nvidia GPU to get the most from the PG279Q with G-Sync, but it does result in a very

smooth, stutter free gaming experience.

The RoG monitor also has a bunch of other gamer-focused features, such as a crosshair overlay, game timer and frame per second counter overlay. The excellent OSD (with joystick interface) also includes presets for different game types, and there's a hardware hotkey for quickly switching between different refresh rates. The PG279Q stand is top notch, with full height, pivot, tilt and swivel adjustments, as well as indicators to make it easy to reset your exact setup.

Round the back, the monitor has HDMI and DisplayPort inputs, as well as a 3.5mm earphone jack, and two USB 3.0 ports.

Verdict

A featureset almost without compare, but only for those able to handle the premium price.



✓✓✓
apc
RECOMMENDS



\$389 | WWW.ASUS.COM/AU

Panel: 23.8-inch IPS; Resolution: 2,560 x 1440;
Refresh rate: 60Hz

ASUS VX24AH

A 24-incher designed for both work and play.

As nice as it would be to have a dedicated gaming monitor, most of us also use our computers for loads of other tasks. As a compromise, the ASUS VX24AH skips some of the more hardcore gaming qualities without going too far. The 23.8-inch screen has a high 2K (2,560 x 1,440) resolution, and uses an IPS panel. This means it has wide viewing angles, and can display 100% of the sRGB colour spectrum. While it does not support higher refresh rates or adaptive sync, the monitor still has a low 5ms response time.

Those wanting to gain every split-second FPS advantage should look elsewhere, but for normal gaming, the VX24AH performs quite well. It also has a bunch of gaming-focused features, such as a dedicated game mode, on screen crosshair and timer. The monitor needs a reasonable powerful GPU to drive it at 60fps at native

resolution, but it also has built-in downscaling to run as a lower resolution for taxing games.

The monitor has no real issues with ghosting or tearing during fast paced action, and the game mode helps highlight dark areas.

The image quality is excellent, with rich vibrant colours and a very even backlight. It also has a flicker free backlight, and a blue light filter, to help ease eye strain.

Round the back, the monitor has dual HDMI ports, VGA and a 3.5mm jack. The stand has the basic tilt adjustment, and the internal speakers are serviceable if a bit tinny.

Verdict

Excellent image quality and feature set from a monitor that successfully handles work and play.





\$679 | WWW.ZOWIE.BENQ.COM

Panel: 24.5-inch TN; Resolution: 1,920 x 1,080;
Refresh rate: 240Hz with AMD FreeSync

BenQ Zowie XL2540

One aimed at esports gamers.

To be upfront, the BenQ XL2540 is not for everyday gamers. It's not even for most hardcore gamers. Instead, it's totally aimed at competitive gamers, or those who want to push their high-speed gaming experience as far as possible. The monitor is packed with features not seen elsewhere, including the monster 240Hz refresh rate. The screen itself is a 24.5-inch TN panel, sporting a not-so-exciting 1,920 x 1,080 resolution. But combined with the 1ms response time and FreeSync support, the BenQ gives a unique experience.

As far as TN panels go, the BenQ performs pretty well, with vibrant colours, not terrible viewing angles and even backlighting. While the monitor supports FreeSync, the idea is that you will always be running at +240fps when using it. BenQ even warn users on the website – the XL2540 is a screen that needs a powerful gaming PC to push

it to its limits. Of course, in use, screens with a lower refresh rate can't compare, and we are still going through withdrawal symptoms. The monitor offers a decent array of inputs, including two HDMI ports, DVI, DisplayPort and USB.

The BenQ has been tweaked to suit pro gamers, with features such as a black equaliser to help show enemies in dark locations, fold out blinders, to block unwanted distractions, a pop-out holder for your headset and a fully adjustable stand.

The XL2540 also comes with the S-Switch – a little dongle that makes it quick to swap between inputs or saved configurations.

Verdict

A monitor without compare for pro gamers, but overkill for almost everyone else.



\$899 | WWW.ZOWIE.BENQ.COM

Panel: 27-inch TN; Resolution: 2,560 x 1,440; Refresh Rate: 144Hz

BenQ Zowie XL2735

For truly fast-paced gaming.

While many brands promise Pro gaming-focused monitors, few take it as far as BenQ, and the Zowie XL2735 is no exception. The 27-inch screen features a 2,560 x 1,440 resolution, as well as a very fast 144Hz refresh rate. It is a TN panel, of course, with an excellent 1ms response time.

The XL2735 doesn't include G-Sync or even FreeSync support, so relies on the gaming rig to maintain a very high framerate. Our test setup had no issues with this, of course, and the BenQ monitor is gloriously fast and smooth to game on. This is helped in part by BenQ's own Dynamic Accuracy tech, which helps eliminate blurring for a more accurate experience.

In day-to-day use, the TN panel is closer to serviceable, than stand out – still, colours and viewing angles are decent and the backlit is even.

Round the back, the monitor has dual HDMI, DVI, DisplayPort and USB inputs. The XL2735 is packed with other pro gaming features, including a black equaliser that makes it easier to see in dark areas without overexposing in bright locations.

The stand is superb, with full height, pivot, tilt and swivel adjustments, and indicators to make it easy to reset back to the same settings. The screen even has fold-out blinders to block distractions, and a pop-out headset holder.

But one of our favourite additions is the S-Switch, also seen in the XL2540 – a handy dongle that allows easy switching between inputs and profile, as well as OSD control.

Verdict

Great for pro gamers chasing every advantage, but for the price, it faces stiff competition from rivals.



Gaming monitor quick setup guide

Get up and running with your new display quickly with our five-minute setup guide.

Plugging in a monitor and firing up your favourite game is easy, but actually getting the most out of all the options and settings is slightly trickier. To help out, we've put together this guide, ranging from the basic, through to the complex.

MONITOR POSITION

Most higher-end gaming monitors have very adjustable stands, but even with a basic model, it's important to set it up well. When sitting in front of your screen, the top should be about level with the top of your head — or to put it another way, your eyes should be about 10cm from the top bezel. Place the monitor about an arm's length away, and tilt it slightly back. Avoid reflections from behind, and adjust the brightness to suit your environment. Some monitors include a dongle for adjusting setting and switching modes, which also avoid bumping your perfect positioning reaching for buttons.

ADAPTIVE SYNC

While VESA Adaptive Sync is GPU brand agnostic, in practice, it's only supported by AMD, via FreeSync and Intel. Nvidia's G-Sync can only be used with Nvidia GPUs. While using either is straightforward, some games or setups can make it fiddly. Make sure G-Sync or FreeSync is enabled in your GPU software first of all. In your actual game settings, make sure v-sync, and any framerate limiting, are turned off. For more in-depth tweaking (such as minimising input lag), do a Google search — there are entire guides online dedicated to specific games.

MONITOR SETTINGS

Few monitors are not improved by some manual tweaking of the settings, but what looks best can be very subjective. We tend to prefer a lower brightness, more contrast, and colours nudged further towards blue. Most decent gaming monitors have entire guides written about different tweaking methods — so as always, break out Google. Nvidia also has calibration guide that is a useful starting point (goo.gl/37GcGP). Windows has a built-in colour calibration tool — head to 'Display Settings > Advanced display settings > Colour calibration'.

GAME MODES

Most monitors have presets for getting the best out of each game. While handy, we often find they are a bit extreme, but a good place to start your own manual tweaking. Another common option is a dark enhancer, which brightens shadowy areas enemies could hide in, without overexposing the entire scene. For FPS

games, this can be very handy, but keep in mind it might ruin some of the atmosphere of scarier games. Gaming monitors also include built-in features such as on-screen crosshairs, game timers and FPS counters that are well worth trying.

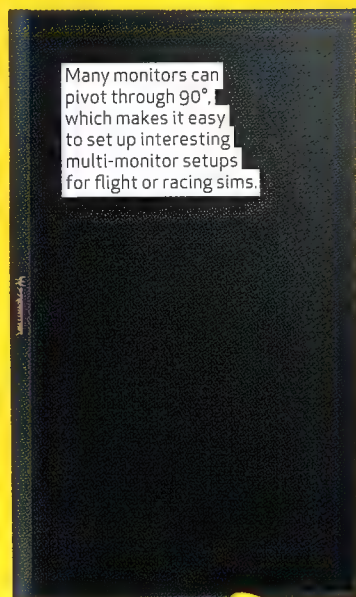
AUDIO SETUP

Most gaming monitors have built-in speakers, but they are usually somewhat

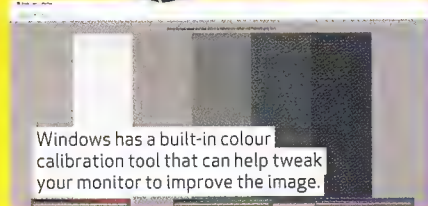
tinny and only good for backup use. But you may have noticed a 3.5mm audio jack, which outputs sound fed through the HDMI cable. This allows headphones to be plugged directly into the monitor. While not usually a big deal for PC gaming, it's handy when using with a console. You can choose to output audio from your soundcard, or via HDMI to the monitor, through 'Control Panel > Sound'.



The best gaming stands are fully adjustable and include indicators to make them easy to move back to your exact preferred position.



Many monitors can pivot through 90°, which makes it easy to set up interesting multi-monitor setups for flight or racing sims.



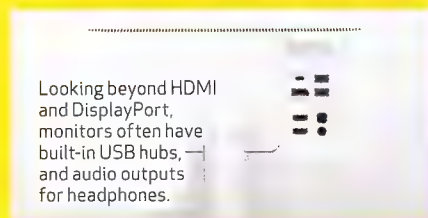
Windows has a built-in colour calibration tool that can help tweak your monitor to improve the image.



G-Sync uses a special chip built in to the monitor, and only works with Nvidia GPUs, but does an excellent job of eliminating screen tearing.



Some gaming monitors include a USB dongle that makes changing OSD settings and switching modes fast and easy.



Looking beyond HDMI and DisplayPort, monitors often have built-in USB hubs, and audio outputs for headphones.

"Gaming monitors also include built-in features such as on-screen crosshairs, game timers and FPS counters that are well worth trying."



\$899 | WWW.LG.COM/AU

Panel: 27-inch IPS; Resolution: 3,840 x 2,160;
Refresh rate: 60Hz with AMD FreeSync

LG 27UD88

Does high-resolution 4K gaming make sense?

Not every gamer is chasing the fastest refresh rates, and many need a screen that has a compelling range of features outside of gaming. The LG 27UD88 is an interesting mix, with a very high 4K (3,840 x 2,160) resolution, yet is also FreeSync compatible. The 27-inch screen uses an IPS panel that can display over 99% of the sRGB colour spectrum, and has a 5ms response time.

In other words, it's a large, high-quality screen that can handle all sorts of use, such as video or picture editing. And despite only having a maximum refresh rate of 60Hz, FreeSync actually makes it a decent gaming option. This is because of the high resolution, most GPUs can't drive it above 60fps anyway, and FreeSync ensures no tearing or stuttering when the frame rate drops.

In practice, it works quite well, and we managed a smooth experience on even

a mid-range GPU. The 5ms GTG response time is not the lowest, but we didn't experience any noticeable ghosting during gaming. Not surprisingly, the 27UD88 looks stunning, and has very rich, even colours.

The LG monitor also includes a few more gaming features, such as preset game modes, and a black equaliser to lighten up shadowy areas.

The 27UD88 includes two HDMI ports and two DisplayPort inputs, as well as USB-C. Impressively, though, it's not just for data transfers, and supports 4K video and laptop charging. This makes the monitor ideal to pair with a laptop without needing more than one cable.

Verdict

Impressive image quality with enough gaming-focused features for fun casual play.



\$249 | WWW.VIEWSONIC.COM.AU

Panel: 27-inch TN; Resolution: 1,920 x 1,080;
Refresh rate: 75Hz with AMD FreeSync

ViewSonic VX2757-mhd

Unbeatable value on a budget.

Not everyone has \$500 to spend on a gaming monitor and, at the lower end, choices are limited. But it's easy to recommend the ViewSonic VX2757-mhd, which can be bought for under \$250. At first glance, a 27-inch, TN-based 1,920 x 1,080 screen doesn't seem that compelling. But the VX2757-mhd has a trick up its sleeve – a 75Hz refresh rate, and FreeSync support. This combination is ideal for older, or more budget-focused gaming rigs, who still want to maximise frame rates.

The ViewSonic engineers have also worked to reduce the input lag and included a range of game modes. At the native resolution, it doesn't take an overly powerful GPU to push the ViewSonic VX2757-mhd beyond the usual 60Hz, and FreeSync runs from 47Hz up.

In our testing, it worked well to give a seamless, stutter- and tear-free gaming experience, with no ghosting. The TN panel

suffers from the usual reduced viewing angles, but the colours are quite vibrant. There is some backlight bleed visible, and the screen benefits from manual tweaking, but overall it gives a remarkable result for the price. You do need DisplayPort to use FreeSync, and only an HDMI cable is included in the box.

The VX2757-mhd stand only has basic tilt adjustment, but has a cable management clip. Round the back, it has HDMI, DisplayPort and VGA inputs as well as 3.5mm audio jacks.

The ViewSonic VX57 series also includes an otherwise identical 22-inch and 24-inch models, for \$169 and \$179, respectively.

Verdict

Fantastic value for AMD gamers who want to experience higher refresh rates on a budget.





\$899 | WWW.VIEWSONIC.COM.AU

Panel: 27-inch IPS; Resolution: 2,560 x 1,440;
Refresh rate: 165Hz with Nvidia G-Sync

ViewSonic XG2703-GS

Built for hardcore gamers.

Not everyone wants to sacrifice image quality for an extra gaming edge, so the ViewSonic wizards have put together the the GS. Importantly, the monitor has a 27-inch IPS panel, for wide viewing angles and more accurate colours. It also has a 2,560 x 1,440 resolution and a low 4ms response time. For smoother gaming, it offers a nice high 165Hz refresh rate, and includes G-Sync to avoid any screen tearing.

The understated green trim on the XG2703-GS is a pleasant change from most gaming monitors, and it stands out without being over the top. The stand is excellent, with full height, pivot, tilt and swivel adjustments, and even a fold-out headset hook. It has the usual HDMI and DisplayPort inputs, as well as a 3.5mm audio jack and USB.

After a little tweaking, the XG2703-GS manages impressive image quality, with very even colours –

even when viewed off-angle. Contrast and backlight uniformity are quite good, though there is a tiny amount of light bleed visible in the corners. Like any G-Sync monitor, it does need a powerful Nvidia GPU to make use of the high refresh rate, but is amazingly smooth and free of any tearing or stutter. While the 4ms response time is higher than an TN panel, we couldn't see any ghosting or blur.

The XG2703-GS includes a range of game modes, but it's well worth customising yourself through the in-depth OSD. The screen also has a dark boost function, to make it easier to see enemies in the shadows, without overexposing bright areas.

Verdict

A great bundle of features for those who want image quality and ultra-fast Nvidia gaming.



\$399 | WWW.VIEWSONIC.COM.AU

Panel: 24-inch TN; Resolution: 1,920 x 1,080;
Refresh rate: 144Hz with AMD FreeSync

ViewSonic XG2401

A more affordable high Hz option.

While G-Sync tech and 2,560 x 1,440 resolutions are undeniably great, not everyone has a PC capable of using all that potential. So instead, the ViewSonic XG2401 winds things back a little, while still appealing to higher-end gamers.

For a start, it's a 24-inch TN panel with a 1,920 x 1,080 resolution and a 144Hz refresh rate. This means it has an excellent 1ms response time, yet can still be driven at a high framerate by a more modest PC. To ensure the fun is not ruined by tearing or stutter, the screen also supports FreeSync. At this stage, that means you will only get the full benefit of the screen with an AMD GPU.

As far as TN panels go, the XG2401 has decent enough viewing angles, and colour reproduction. The backlighting is also very even, with no real bleed. The real wow factor doesn't come until you start

gaming at 144Hz, where the screen is very fast, smooth and totally tear free. Enabling the game modes can help adjust the settings for a particular play style, but it's well worth delving in and tweaking it yourself. The monitor also has a handy black stabilisation feature that makes it easier to spot foes hiding in the shadows.

At first glance, the XG2401 is somewhat plain, but it does have a very slick stand, with full height, pivot, swivel and tilt adjustments, and a cable organiser on the back.

Handily, the screen includes dual HDMI inputs, as well as DisplayPort (needed for adaptive sync) as well as two USB ports.

Verdict

Smooth high refresh rate gaming without having to blow out the budget.





Keyed up

Harry Domanski, Joel Burgess and Dan Gardiner get their fingers into 2017's top gaming keyboards to see what new features click, and what's just colourful fancy.

While per-key RGB keyboard backlighting is the hot new trend on gaming laptops in 2017, the multicoloured backlighting system is basically now a staple amongst dedicated high-end PC keyboards this year. The upshot of this ubiquity is that the software from various vendors is sophisticated enough to allow fully colour-coded key arrangements and lighting profile synchronisation across multiple peripherals.

While there is one membrane keyboard in the roundup, it's clear that the market has radically shifted away from this cheaper (and quieter) interface tech. As always, Cherry switches underpin the vast majority of mechanical keyboards available, although Razer and SteelSeries are determined to build their own switches from the ground up.

Also divided is the landscape between vendors that make you settle for the mechanical key type it's decided on for a particular keyboard model and those that'll let you swap in your choice of switches. Occasionally, a key style will line up with the specific niche that a vendor is spruiking, but generally, vendors try to give you your choice of loud actuation feedback, a subtle bump or the consistent resistance found in the respective Blue, Brown or Red mechanical key switches, on whatever keyboard they can.

Logitech has broken the mould with a wireless mechanical keyboard (G613, p48), but as much as we hate the girthy data pipes connecting your keyboard to your PC (especially the double and sometimes triple cabled keyboards with USB passthrough and audio inputs), the lack of backlighting is a big hinderance that makes it seem like there isn't a particularly bright future for wireless gaming keyboards. That said, around the \$150 sweet spot, there's a number of excellent contenders that'll give you the responsiveness and comfort of a professional gaming keyboard, with a few perks like RGB lighting and macro key configurations, thrown in.

\$169 | COOLERMASTER.COM

Cherry MX Red, Blue or Brown switches; per-key RGB; detachable cable; 43.9 x 13.0 x 4.2cm; 1,090g

Cooler Master MasterKeys Pro L

Innocuous black rectangle by day...

The MasterKeys Pro L design is incredibly utilitarian and relatively portable, with a thin bezel and only a few peeks of keyless surface to be seen, but the functionality doesn't live up to its spartan appearance.

This unit is one of the more wallet-friendly offerings in the RGB world of mechanical gaming keyboards, especially considering the Cherry MX switches. The cable is braided and detachable, plugged in via micro-USB, and there are cable-management guides to feed it left, right or centre.

Cooler Master offers a range of three different MasterKeys Pro sizes, the M has an even more crammed surface, melting the numpad into the arrow keys and losing the dedicated profile keys, while the S removes the numpad altogether. Although the regular-sized keys felt sturdy and stable,

the spacebar was particularly flimsy and rattled obnoxiously with every tap.

The software allows for per-key RGB control and includes an impressive array of effects, our favourite of which allows you to play a game of Snake on the keyboard, navigating with the arrow keys. While the lighting control is simple and intuitive in the software, it lacks any kind of macro organisation and leaves it up to the physical keyboard to record and manage them. This on-the-fly macro management isn't explained in any documentation and we had to watch a video to figure out the correct key-sequence for recording.

Verdict

If you don't use macros, then this is a fine keyboard, just not the best for the asking price.





\$195 | CORSAIR.COM

Cherry MX Speed (Silver) switches; per-key RGB; 43.9 x 13.0 x 4.2cm; 1,090g;

Corsair K70 RGB RapidFire

Fast and furiously premium.

Corsair is clearly aiming for the premium with the K70 RGB RapidFire, and for the most part, its aim is true. The switches and keys are all surface-mounted and look particularly striking atop the brushed aluminium face – especially when the RGB lights are in full swing. The detachable palm rest is a pleasant rubberised plastic to alleviate the harshness of the brushed aluminium.

It has a wealth of included conveniences, including USB passthrough port, dedicated polling rate switch, kick-feet, dedicated media controls and a volume slider. The keycaps have a slightly shorter face than standard and come with a larger font, plus Corsair is using Cherry MX Speed (Silver) switches which have a shorter actuation distance for faster typing. While the majority of the smaller keys feel solid, snappy and responsive, the larger keys have an uncomfortable

wobble and loud rattle when typing, and the spacebar comes with the same faux diamond plate texture found on the replacement keys. The USB cable is braided and exceptionally chunky thanks to the dual-USB plugs on the other end – you'll need both if you're using USB 2.0 but only one for 3.0. Corsair's software is incredibly detailed in both its macro and lighting configuration options, ideal for tweaking but a bit of a hindrance for simple adjustments.

The premium build and unique aesthetic far outweigh the shortcomings of the K70 RGB Rapidfire, but you'll have to decide if this balances out to \$195 worth of keyboard.

Verdict

A premium in both style and price, but with lots of added extras to soften the hit to the wallet.



\$150 | WWW.ASUS.COM/AU

Mechanical Kaihua Kailh Red, Blue, Brown or Black switches; per-key RGB; 44.8 x 15.0 x 3.5cm; 1,250g

ASUS Cerberus Mechanical RGB

Illumination at a decent price.

ASUS is looking to change the playing field with its latest entry-level Cerberus device, with this mechanical RGB gaming keyboard promising great specs at a price that most of us can actually afford.

Lay your hands on this baby and you'll immediately notice the rubberised plastic that covers every surface – this is both a pleasure to touch and an instant smudge magnet. While the four included spare keycaps don't get this rubber treatment, their orange-red colour ensures those WSAD keys still really stand out.

The keyboard can lay flat or at a slight angle, but those who like a palm rest will need to look elsewhere. With the minimalistic aesthetic, the only strong assertion that this is a gaming keyboard is the RGB backlighting, offering seven different lighting effects and per-key colour configurations. You can save these effects to any

of the six profiles, along with any macros you record, and switching between them is a matter of hitting the appropriate function keys. The ease of configuration is one of the Cerberus keyboard's greatest strengths, with the ASUS Armoury software making short work of setting up new profiles, although to a degree, that is at the expense of more elaborate light-effect tweaking. The switches are Kaihua branded and come in the familiar Red, Blue, Brown and Black – the Red switches we tested felt almost identical to their Cherry counterparts, with just ever-so slightly less resistance.

Verdict

The simplicity of the Cerberus will be a key selling point, rather than a drawback.





\$129 | FNATICGEAR.COM

Cherry MX Red, Blue, or Brown switches; red LED backlighting with variable brightness; 44.8 x 14.8 x 3.3cm; 1,275g

Fnatic Gear Rush G1

There is beauty in simplicity.

The Rush G1 is the least expensive keyboard on our list, so what are you missing out on when you save this much dosh?

Well, this keyboard only has red LED backlights for the keys, so your lighting options are limited to four different brightness settings and a pulsing mode, although the shortcomings more or less end there.

Its aesthetic is understated and the grey-on-black logo is the only indicator that it isn't an office keyboard when the lights are off. The rubberised plastic finish on the frame and detachable palm rest feel premium, as does the braided USB cable. The G1 also provides USB passthrough with two additional USB ports on the rear of the keyboard, improving accessibility for extra peripherals and giving your rig a bonus port in the process.

The keycaps are of a standard size and are regularly spaced, and this

is definitely one of the most affordable keyboards to feature Cherry MX mechanical switches. We tested the unit with Brown switches and found the travel to be comfortable and the noise produced to be a pleasant dull thud rather than an irritating high-pitched click.

The software is incredibly simple and we found it easy to set up the macros (you can assign up to 10 for each of the five profiles), although an on-the-fly macro recording option would have been a welcome inclusion.

For those after a gaming keyboard with all the essentials but aren't all that keen on forking out big dollars on a lightshow.

Verdict

We heartily recommend the Fnatic Gear Rush G1 for those who don't need all the glitz of RGB.



\$149 | WWW.HYPERXGAMING.COM

Cherry MX Red switches; red LED backlighting; 44.4cm x 22.7 x 3.6cm; 1,467g

HyperX Alloy Elite

This keyboard might look flashy, but does it actually paint the town red.

Add a luxurious 18 zone LED light bar, a suite of media controls and a generous rubbery palm rest to HyperX's well received Alloy FPS and you have the elevator pitch for the latest keyboard from the relatively new peripherals competitor.

The HyperX Alloy Elite is built from a solid steel frame and comes with a generously sized palm rest that give this keyboard a unique sturdiness. If you're attracted to the RGB lights of the latest gaming keyboards, you'll be disappointed by the red only LED lighting across the Hyper Elite, but for those who see keyboards through rose coloured glasses, the local version of this keyboard puts everything on red by adding Cherry Red switches.

The included N-key rollover, anti-ghosting technology and an 1,000Hz polling rate add to what is, all up, a pretty good feature set, but there are some

considerable limitations you'll have to be on board with. Most notably is that the Alloy Elite has no companion software whatsoever. This means no customisable function keys, no controllable lighting schemes and no recorded macros. When other vendors offer this, it's hard to not feel as though you're missing out, but in reality, the best element of per-key RGB lighting is the ability to custom colour gaming keys – a feature that the Alloy Elite compensates for with eight swappable silver gaming keys and a dedicated WSAD lighting scheme.

Verdict

A quiet, responsive board that is good for typing and gaming, but misses out on a software suite.





\$149 | WWW.LOGITECH.COM

Romer-G switches; 6 dedicated macro keys; wireless; 4.78 x 21.6 x 3.3 cm, 1,460g

Logitech G613

A gaming 'board that really wants to be a business 'board.

The G613 is a gaming 'board that doesn't really look like one. Packing Logitech's own Romer-G mechanical switches – akin to Cherry Reds in terms of feel, but with more stability due to the switch's wider, flatter shape – it's a pleasure to type on and the metal plate under the keys means it's as sturdy as a mountain goat (and weighs about as much as one too).

What really sets the G613 apart, however, is that it's wireless, using the same transmission-tech inside Logitech's wireless gaming mice. That means there's zero lag between striking a key and the action occurring in-game – we couldn't notice any subjective difference between using this 'board versus the G Pro Tenkeyless (see right) when it came to responsiveness.

While this board includes a bank of six macro-able keys on the left side of the board and a Gaming Mode switch that disables the two Windows keys, there's no

key backlighting, as it'd drain the batteries too fast.

The board is also huge, with a palm rest that isn't removable, and its higher 1.4kg weight means it's easy or comfortable to move around or use on your lap.

So what about as a non-gaming board? Well, that metal plate has a tendency to quietly twang from the impact of keys hitting their base. That might not be a huge problem when you're gaming, but it's a bit distracting when you're trying to bash out that Great Australian Novel in your study.

Ultimately, it's a bit stuck in the middle between wanting to be a gaming 'board and not – and so ultimately, isn't great for either.

Verdict

A wireless gaming board with a great build quality, but isn't quite right for gamers.



\$149 | WWW.LOGITECH.COM

Romer-G switches; per-key RGB; 36 x 15.3 x 3.4 cm; 980g

Logitech G Pro Tenkeyless

Everything you need, nothing more.

Logitech's G Pro line packs all the basic gaming features without anything that might be considered extraneous. One of the things we like most about this range is that it's deliberately low-key (pun intended) in terms of looks and features – all the Pro keyboards are plain black, with just a glowing G on the top right and the joystick-icon 'gaming mode' button at the top right – you won't find dedicated macro keys or media controls.

They still include glowing, multicoloured backlit keys, of course, but you can turn the latter off, or dial it back to be much more sedate. Logitech also has some of the best software when it comes to configuring that backlighting. It's fast and slick, and we found it made us much more inclined to actually customise keys.

This tenkeyless 'board isn't quite as compact as some of the more extreme examples from this sub-category, but it's still quite

small. Logitech's own Romer-G switches live under those nicely-spaced keycaps, meaning reasonably quiet and very stable typing is the name of the game. In fact, when it comes to gripes, the only one we have is to do with the detachable USB cable, which has a large plug that means the cable sticks awkwardly out the back of the keyboard, right in the middle – something that's made worse when you've got the tenkeyless propped up on its feet.

That's a minor complaint against a 'board that otherwise gets almost everything else right – and you don't need to be a gaming pro to appreciate its charms.

Verdict

Some minor flaws can't diminish the appeal of what's otherwise a near-perfect tenkeyless 'board.





\$159.95 | WWW.ROCCAT.ORG/EN-AU

Membrane keys; single RGB backlight;
50.0 x 24.5 x 2.5cm; 997g

Roccat Isku+ Force FX

A tour de force... maybe.

The Roccat Isku+ Force FX is a gaming keyboard with a name that's almost as intense as its feature list.

The 'Force' part of this membrane-keyboard's name refers to a technology built into its QWERTY keys, a pressure sensitivity that aims to bridge the gap between analog joysticks on console controllers and the on/off nature of computer keys.

Roccat's Swarm configuration software comes with all the fine-tuning options you could need for this feature, letting you assign different pressures to different keys and key combinations, but this function isn't flawless.

Games that use a toggle setting rather than hold-and-move for actions like sprinting or sneaking will render the pressure sensitivity useless, and although you can refine the pressure cut-offs, the process of adapting to it will likely be too much for

most gamers. Outside of this key feature, the form-factor is almost identical to previous iterations, with the same overall bulkiness and a large integrated palm rest.

A fixed palm rest is not ideal, particularly if you aren't a fan of this fairly hefty offering.

You can create and manage up to five profiles in the intuitive software, with key assignments, macro settings, and RGB colours. On the lighting, there are six different brightness settings and a variety of effects but it isn't per-key RGB, and as the media and utility keys can't be lit, the soft grey text on black makes them very difficult to read.

Verdict

The Force FX's pressure-sensing keys mostly work well... when supported.



\$170 | WWW.ROCCAT.ORG

TTC Blue switches; RGB per-key backlighting;
43 x 12.5 x 3.5cm; 865g

Roccat Suora FX

This full sized frameless keyboard is going for simplicity over special effects.

While much of Roccat's keyboard portfolio attempts to convert customers with additional media keys, palm rests or unique lighting, its latest frameless mechanical keyboard seems to be trying to focus on getting the fundamentals right.

By sacrificing the palm rest and additional keys, the Suora FX has been able to keep its footprint compact, a massive perk for anyone a little tight on space. But in addition to cutting a heap of dead weight, this no-frills approach means you aren't distracted by unusual keys.

The Blue Cherry switches give the Suora FX an ostentatious clackiness that is second to none. As far as gaming capabilities go, there isn't much here that distinguishes the keys you'll need for your average FPS, MMO or MOBA, but the keyboard's per-key RGB lighting scheme and the accompanying Roccat Swarm software allows you

to customise your the colours of gaming keys and set up specific profiles if you want to fully colour code keys for particular games.

In addition, you have all the customisation tools you need for remapping keys to a custom configuration that can be toggled on and off by a Game Mode toggle and while there aren't additional keys for media and macro controls, the 6-key Insert/Delete block transforms into configurable macro buttons in this mode.

Most importantly, though, the Suora FX doesn't skimp on the important performance technologies like the advanced anti-ghosting N-Key rollover and a rapid response 1,000Hz polling rate.

Verdict

Distills the important keyboard technologies by cutting away everything else.





\$249 | WWW.RAZERZONE.COM

Razer Green, Orange or Yellow switches; per-key RGB; 47.5 x 17.1 x 3.9cm; 1.5kg

Razer BlackWidow Chroma V2

As expensive as it is exclusive.

Razer has established itself as a force to be reckoned with in the world of gaming peripherals, excelling in gaudy designs, edgy product titles and over-the-top specs, but does the latest iteration of the BlackWidow Chroma live up to the brand's hype?

Aesthetically, there isn't all that much to this device. The glossy plastic areas spoil an otherwise tidy appearance, but thankfully, you can cover up one of these patches with the magnetically-attached palm rest. This rest sports a mega plush cushion with seriously soft pleather and was by far the most comfortable we've tried.

The keyboard itself is a chunky affair, although the heft does lend to the unit's sturdy feel. Razer has developed its own flavour of switch, foregoing the Cherry MX standard, and we found the actuation of the Green (tactile and clicky) switch we tested to be

excellent, but the 'clicky' descriptor is an understatement.

The Synapse software from Razer works for both Windows and Mac and is at once user-friendly and full of fine-tuning possibilities, but you'll need to sign up to use it.

The BlackWidow Chroma has two USB plugs if you want to run it from USB 2.0, along with a 3.5mm cable which, in combination, allows for USB and audio passthrough to the keyboard, which is a great accessibility option for a headset and mouse. There are some clever and useful features on the BlackWidow Chroma V2, but we don't think they're enough to justify the incredible asking price of \$249.

Verdict

While the BlackWidow is packed with features, its aesthetic is dull and it's simply too expensive.



\$249 | STEELSERIES.COM

SteelSeries QX2 switches; per-key RGB lighting; 45.4 x 15.4 x 4.7cm; 998g

Steelseries Apex M750

Strong, but with strong competition.

There's nothing superfluous or even slightly gamer-centric about the M750's appearance; no harsh angles on its smooth aluminium base or obnoxious media keys, just a standard layout with readable, well-lit keys. SteelSeries's Prism lighting system offers a stack of effects that you can store on the keyboard itself or customise through the SteelSeries Engine software, and the transparent switches make for one of the best lightshows we've seen on a gaming keyboard.

The new QX2 switches from SteelSeries are, technically, silent — press them gingerly enough and take advantage of the half-press actuation distance, and there's little to no noise, but there's definitely a clatter with heavier typing. This shorter actuation depth and low-resistance springs may prove a little too sensitive for some, as we found we would accidentally

trigger the keys when resting our digits on them. Despite the otherwise luxurious featureset, the non-braided cable doesn't seem ultra durable and the height adjustment rubber feet seem like a step backwards from the tried-and-tested fold-out feet.

While none of these drawbacks are truly major, and the keyboard is indeed a pleasant and premium offering, the asking price compared with that of its competition makes it difficult to recommend.

For a full per-key RGB mechanical gaming keyboard, you can look at the admirable ASUS ROG Cerberus for \$100 less and, frankly, with a near-identical featureset.

Verdict

Several inconveniences and a hefty price tag ultimately let this keyboard down.





\$120 | AU.TTESPORTS.COM

Cherry MX Red, Blue or Brown switches;
red backlighting; 44.9 x 14.3 x 3.8cm; 1.2kg

Thermaltake Meka Pro

The softwareless macro Meka.

ThermalTake have chosen to focus on the macro with it's Meka Pro, adding a dedicated toggle that allows you to record macros on the fly. While the fact that you can record 31 key sequences using a simple keystroke-based operation will be appealing to anyone who regularly uses macros, it does mean that you miss out on a software suite to help you configure these options and tweak other settings.

The Meka Pro is a full-sized 'board that has ditched the dedicated media keys and palm rest, defaulting to the dual functions of the F keys for useful common shortcuts. Despite the macro focus, this aim to conserve space has relegated the macro keys to the 1-6 keys on the number pad.

The Meka Pro has a red-only lighting arrangement, and though it's not quite as versatile as per-key RGB, it does have four dedicated gaming light modes that will illuminate only the

keys you generally use for particular styles of games.

In addition to this, the keyboard has a number of onboard light shows that can be cycled with the push of a button, a Windows button lock and even a switch for flipping between 6-key rollover and N-key rollover (N-key rollover 'boards aren't compatible with the BIOS on some motherboards).

Offering your choice of Blue, Brown or Red Cherry MX switches and additional red, swappable WSAD and direction keycaps, this board is sure to appeal to plenty of gamers and will be particularly desirable for those looking to bypass the general software setup.

Verdict

A plug-and-play 'board that suits a wide variety of gaming styles and won't break the bank.



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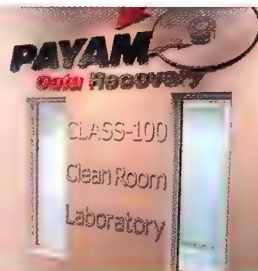
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Mousing off

Make your aim as sharp as your trash talk with one of these incisive gaming mice.

Harry Domanski, Joel Burgess, Dan Gardiner and Ian Evenden test 11 current options.

Just as gamers have harkened back to the days of mechanical switches for their keyboards, we've seen a trend of gaming mice going back to using optical sensors (or, in some cases, optical-hybrid sensors) rather than lasers. Technically, laser sensors are actually a type of optical sensor too, but instead of using an LED to illuminate the surface beneath the mouse for the optical sensor to detect, these use a laser. While the laser light has an increased accuracy over standard LED light due to its different wavelength, it can be a hindrance when it comes to textured surfaces, including rough wood and cloth mousepads, as it can produce far too much detail information about the structure and depth of the surface. This flux in accuracy is most prominent with slower movements – ideally, where you'd want accuracy to be optimal. LED-illuminated sensors, however, produce much flatter information for the sensor to read and so don't suffer the same accuracy loss at lower speeds. That said, laser sensors don't generally suffer from these shortcomings when used with hard pads.

Sensors aside, gaming mice are still being put out with an impressive variety of traits. Whether you game with a claw grip – anchoring your palm and controlling the mouse with your fingertips – or rest your entire hand across the peripheral in a palm grip, the market has you covered. In fact, a good amount of the mice we tested here are suitable for both grips, although often their shapes do slightly favour one over the other.

For the FPS gamer, there are plenty of minimalistic mice that ditch the mess of buttons that come with RTS or MMORPG-oriented offerings. Decent ergonomics, a switchable DPI on-the-fly and reliability is king when it comes to first-person shooting. If you're after ultimate control in the palm of your hands, and want to run macros and pause media with the twitch of a knuckle, then there are still a few mice that will suit your needs.

There's also a nice balance between wireless mice and the freedom that they offer, and the old faithful corded mouse for those that can't afford the chance of a drop-out or dead battery (or just the higher cost of wireless tech in general).



\$129 | WWW.ASUS.COM/AU

Sensor: 7,200dpi optical (model not specified); Design: symmetrical, 4–8 buttons; Cable: 1.8m, braided; Dimensions: 12 x 6.8 x 3.7cm; 103g

ASUS RoG Pugio

Play the hand you're dealt.

The RoG Pugio walks the fine line between complete ambidextrous support and high-performance gaming capabilities and does so with finesse.

The long and flat design and button layout are both functionally symmetrical and feel comfortable in both palm and claw grips. At only 106g, the Pugio is fairly light, and considering the resistance of the relatively stiff braided cable, the mouse sometimes has to battle against this. The ambidextrous features extend to the ability to swap out the two side buttons with a blank, non-clickable panel, giving you the option of having these buttons on either side of the mouse, both sides, or neither. For even further physical customisation, ASUS has incorporated a Push-Fit switch system that allows you to replace the Omron switches with different levels of resistance. The Pugio comes with a

little case for storing the spare switches (a pair of which are included) and the side-buttons or blank panels when not in use.

The RoG Armoury software is user-friendly and offers some serious tweaking, including polling rates, DPI switching and macros, although the limitation of three switchable profiles is unfortunate. If you've got several RoG devices, you can sync all of the RGB lighting effects via this software and get a real cosmic display happening.

Considering the premium features, detailed software, and customisability, the Pugio is definitely worth the \$129, and for left-handed gamers, this is a no-brainer.

Verdict

The ambidextrous nature, coupled with the customisability in both design and software, it's a winner.





\$59 | COOLERMASTER.COM

Sensor: 12,000dpi optical (PMW3360); Design: right-handed, 6 buttons; Cable: 1.8m, plastic; Dimensions: 11.8 x 7.8 x 2.9cm; 135g

Cooler Master MM520

A decent budget option.

It's rare that the words 'budget' and 'gaming' can both be used to describe the same peripheral, but Cooler Master has introduced a pair of very affordable gaming mice that cover both territories well.

The MM520 and MM530 are functionally the same mouse but in a claw-grip and palm-grip form factor, respectively. We reviewed the MM520, but most points can be applied to both.

Deciding to focus on each particular grip style has paid off for Cooler Master, as the MM520 is a pleasure to wield. The material is nice to the touch, if not a little cheap feeling, with a textured plastic covering most of the mouse and a rubber grip for your pinky finger. Despite the Omron switches, the primary buttons feel a little clunky and loud, the scroll-wheel is comically large, and the side buttons get close breaking the sound barrier and are a chore to press. Don't worry, the rest is all good news.

The software is exceptionally detailed and easy to use. With up to five profiles, you can customise three independent RGB zones, complete with effects, and any setting you could imagine for tweaking how the mouse performs.

You can assign all six buttons how you please and with Cooler Master's TactiX feature, you can add secondary functionality to every button when you hold down the appropriate key.

While the component quality seems a little average, it's to be expected at \$59 and, considering the fully-featured software capabilities, this is certainly the mouse we recommend for gamers with tight wallets.

Verdict

While the feature list may seem underwhelming, the price and grip-specific designs are great.



\$139 | WWW.CORSAIR.COM

Sensor: 16,000 DPI optical (custom); Design: right-handed, 6 buttons; Cable: 1.8m braided; Dimensions: 12.5 x 9.1 x 4.5cm; 122g

Corsair Glaive RGB

Fits like a glaive.

While it's not uncommon to see interchangeable buttons and weights, Corsair's Glaive RGB mouse takes the modular concept a step further.

The three magnetically held smooth, textured and winged thumb options give the ideal support for multiple grip styles, but the design feature does rule out lefties.

Like most of the high-end gaming options we've looked at here, the Glaive offers RGB LED lighting, but this is broken into three separately configurable areas to fully customise the lighting profile. There are two thumb buttons, a scroll wheel and a DPI toggle, in addition to the two main triggers, but as far as the number of buttons goes, the Glaive is rather streamlined. Although the scroll wheel is nicely weighted, it only offers a notched/ ratcheted system that won't appeal to everyone and misses out

on the left and right directional clicks that occasionally accompany the centre click.

Corsair's Unity Engine does a good job of integrating the mouse with other Corsair peripherals and allows you to customise lighting, button mapping, macros and sensitivity defaults and presets. There's also a useful surface calibration setting that adjusts the responsiveness of the mouse based on the particular surface you're on.

The overall ergonomics of the device are good with a comfortable arch and nice soft plastic shell, but the mouse did radiate a little more heat than we're comfortable with, making it not ideal for long gaming sessions.

Verdict

A comfortable and full featured mouse that offers fast-swap thumb rests and advanced colour controls.





\$55 | FNATICGEAR.COM

Sensor: 5,000dpi optical (Pixart PMW3310); Design: right-handed, 6 buttons; Cable: 2m; Dimensions: 12.6 x 6.8 x 4cm; 90 g



\$79 | WWW.HYPERXGAMING.COM

Sensor: 3,200dpi optical (Pixart 3310); Design: Right-handed, 6 buttons; Cable: 1.8m braided; Dimensions: 12.7 x 4.2 x 7.1cm; 95g

Fnatic Gear Flick G1

An entry-level gaming mouse with some premium features.

With some vendors selling it for as little as \$55, the Fnatic Gear Flick G1 is one of the least expensive gaming mice we've included in the roundup, but this isn't something many people would be able to pick out just from looking at it.

The powdery plastic exterior is comprised of three simple continuous slices plastic that are stitched together by two symmetrical, arching seams that reveal a series of recessed white-LED DPI-level lights. Throw in an RGB colour wheel, a simple black DPI sensitivity toggle and a forward and back thumb trigger and you get a particularly sleek-looking gaming mouse. The near symmetrical ergonomics give the impression that this is an ambidextrous mouse, but the two non-removable thumb controls sit under your knuckles and are too far away to be reached when using your left hand. The Flick Settings app's

button mapping, sensitivity, profile configurations, colour alterations, and macro settings sections were all easy to navigate and contained everything you'd expect.

As it turns out, though, the sterling experience of the Flick G1 was belayed a little by it's choice of the Pixart 3310 optical sensor, which had some serious difficulties operating on a slightly shiny white table, a problem we didn't notice on the more expensive devices. That said, the G1 worked as good as anything else on a gaming mat.

Even if you factor in the cost of a good mousepad, the Flick G1 optical gaming mouse is still a great mouse with all the bells and whistles.

Verdict

An inexpensive gaming mouse that offers a raft of advanced features and looks exceptionally sleek.



HyperX PulseFire FPS

Decent value for a gaming mouse, but a tokenistic offering.

HyperX's first mouse rounds-out its gaming peripheral lineup, but is it more than a piece for the completionist?

Upon first inspection, you'd be forgiven for mistaking the PulseFire FPS for a rebranded Razer DeathAdder Chroma – the aesthetics are common to both products, as is the focus on durability, utility, and value rather than over-the-top customisation. That said, this mouse does have one significant leg-up in the form of a dedicated DPI button, a feature only found on Razer's higher-end DeathAdder Elite, which costs around \$15 more. This button cycles through its four preset settings, from 400 to 3,200dpi, and alters the lighting colour to indicate the change.

The construction of the PulseFire FPS feels solid, with durable Omron switches under the main buttons that are satisfying and responsive, a lovely braided cable and a suitably

clingy textured grip. The mouse is still quite lightweight at 95g.

Given its elongated shape, the form is more suitably molded for a palm grip and is exclusively for right-handers – both traits that are, again, shared with the DeathAdder series.

Given that the PulseFire FPS comes in at \$79, this puts it in-between Razer's DeathAdder Chroma (\$69) and the DeathAdder Elite (\$99). This makes it excellent value if you need that DPI-switching capability, but the lack of software, custom lighting and a slightly less flexible sensor make it tough to outright recommend over the cheaper Chroma – at least until we see a bit of a drop in price.

Verdict

A solid-feeling gaming mouse, but its limited featureset makes it hard to justify that price.





apc
HOT PRODUCT

\$149 | WWW.LOGITECH.COM

Sensor: 12,000dpi optical (PMW3366); Design: right-handed, 6 buttons;
Cable: wireless; includes 1.8m braided cable for charging;
Dimensions: 12.4 x 6.8 x 4.3cm; 107g

Logitech G703

A classy wireless gaming mouse for a very reasonable price.

Logitech's G903 is its premium wireless mouse, but it won't appeal to all tastes. The company thankfully has another option, though: the ergonomically shaped G703. While it has fewer features and customisation options than the higher-end G903, the main difference is that this one has a flatter and wider design that's a bit more comfy for palm-grippers – although at 107g, it's still lightweight enough that more finger-oriented grip styles work fine, too.

The pain point for wireless mice is recharging them, but if you're willing to fork out another \$150 to get Logitech's Powerplay mat, you'll never have to worry about this, as it charges the G703 via induction. Even without that mat, charging is fairly seamless: there's a 1.8m braided USB cable included in the box, plugs into the front of the mouse to charge it. That cable doesn't impede performance, so when

tethered, the G703 works just like an other wired gaming mouse. With 2–3 hours of gaming per day with medium/high-sensitivity settings, we found ourselves recharging the mouse every 1.5 weeks or so – almost bang-on Logitech's claimed 32 hours.

There's little between the G703 and G903 – both use the same sensor (the Pixar PMW3366, 200–12,000dpi) and software for sensitivity, button and lighting configuration. The G703 has only one DPI button, though, so you need to cycle through different sensitivity settings, rather than move back and forth, but it's well-equipped with six programmable buttons and still packs in all the really critical elements.

Verdict

A cheaper wireless mouse that's arguably better than its more expensive sibling.



apc
RECOMMENDS

\$69 | WWW.LOGITECH.COM

Sensor: 12,000dpi optical (PMW3366); Design: right-handed, 6 buttons;
Cable: 2m, braided; Dimensions: 11.7 x 6.2 x 3.8cm; 85g

Logitech G Pro Gaming Mouse

Rodent prowess.

The G Pro is part of Logitech's range of stripped-back gaming products, with fewer features but better build quality. (Why it still has 16.8 million colours of LED lighting, though, is beyond us...) You only get the standard six buttons on this model, but they're well positioned, and all programmable using Logitech's excellent software, which is some of the most-polished and intuitive in the biz.

The casing is black plastic in a more classic rounded shape, with the shell unbroken apart from splits around the buttons, and the gaps for the (dreaded) lighting. It's unadorned with grippy panels or thumb-rests, leading to a spartan look, offset by a single shiny patch forward of the scroll-wheel. That rolling disc itself is pleasingly broad, deeply ridged, and takes a comfortable shove to go from one notch to the next. There's nothing special

about the wheel's finish, however – it's just a plastic circle without a rubber tire or soft-touch coating, but it is well designed and fairly satisfying to use.

Feel is everything for a peripheral that spends so much time in your hand. It's engineered to be extremely accurate, with the fairly-ubiquitous PMW3366 optical sensor (used in almost all of Logitech's gaming mice), the absence of any smoothing or pixel rounding, and some clever metal springs under the main buttons; the nicely braided cord is a decent 2m in length; and its smooth matte finish feels good in the hand.

Verdict

Built for accuracy with a solid body and well-placed switches.





\$99 | WWW.RAZERZONE.COM

Sensor: 16,000dpi optical (Razer 5G); Design: right-handed, 7 buttons;
Cable: 2.1m, braided; Dimensions: 12.7 x 7 x 4.4cm; 105g

Razer DeathAdder Elite

It's the return of the king... again!

The DeathAdder design has remained popular and in production since 2006. It's seen many upgrades over the years – this Elite is from late 2016, and it's predecessor – the still available (and very-good) Chroma – was released in 2014.

So how do you make an already-great mouse better? Razer's answer has been to improve the build quality and durability by swapping to mechanical button switches and a 16,000dpi optical sensor. Now, for most players, that sensor is complete overkill, but those new switches are certainly a plus – and they're a bit quieter, too.

Razer's also changed the textured rubber used on the scroll wheel – rather than being made up of grooved horizontal ridges, there are now evenly-spaced sets of three raised nodules. That does seem to increase the overall grippiness, but isn't quite as comfortable as the old ridged design. There's

also a set of DPI switching buttons behind that wheel, so you can now change sensitivity on the fly.

In testing, we were able to be as accurate on this mouse as with the Chroma. That said, at our preferred 1,800dpi setting, there's not a lot between them.

For now, the Elite's only available in a right-handed design, and it's still a very lightweight mouse at 105g, so if you're a lefty or you prefer a heavier mouse, you should look elsewhere.

For everyone else, this is the best lightweight gaming mouse on the market. At present, you'll pay an extra \$20 for it over the Chroma, but the latter's getting a bit long in the tooth, so it's worth the extra in our book.

Verdict

Our favourite gaming mouse just got better, but it's not for lefties or those who like a heavier mouse.



\$229 | WWW.ROCCAT.ORG

Sensor: 12,000dpi optical (Owl-eye); Design: right-handed, 16 buttons;
Cable: wireless with charging dock; Dimensions: 12.6 x 8 x 4.5cm; 134g

Roccat Leadr Wireless Mouse

Performance and wireless play nice.

The Leadr is bristling with input options – 10 buttons, a pair of two-way paddles and a scroll wheel – yet somehow the aesthetic manages to remain relatively sleek. Although limited to right-handers, its ergonomic profile is well suited for claw grips and palm grips alike.

At 134g, the Leadr is light enough to fly across the mousepad but still has enough heft to feel substantial in the hand. Roccat includes a modified Owl-Eye optical sensor from PixArt and, despite being wireless, we noticed no latency or drops in precision. The included charging dock doubles as the 2.4GHz antenna and connects via micro-USB to your computer – the same cable can be used to plug into your mouse if you're out of juice. The dock stands vertically and displays your Leadr like a mounted elk head when charging. Beyond the immediate combination of 16 configurable inputs,

one of these can be assigned to Roccat's EasyShift[+] function, which, when held, allows access to secondary functions for nine of the top-facing buttons. This leaves you with 25 configurable commands across five profiles to alter at will via the Roccat Swarm software. You can assign an ungodly amount of functions to any of those 25 assignable buttons, such as media controls, macros and actions from popular games, launching applications, and command line prompts.

At \$229, the Roccat Leadr isn't cheap, but if you're after excellent quality and extreme functionality in a wireless gaming mouse, then this is your weapon of choice.

Verdict

While it's a bit of a hit to the wallet, there's an almost ridiculous amount of tweaking options here.





\$99 | STEELSERIES.COM

Sensor: 12,000dpi optical (SteelSeries TrueMove 3); Design: right-handed, 6 buttons; Cable: 2m; Dimensions: 12.8 x 7 x 4.2cm, 88.3g

SteelSeries Rival 310

A mouse that won't break the bank.

The new Rival from SteelSeries certainly punches above its cost, proving that you don't need to drop big dollars to get the top-of-the-line experience,

The Rival's new TrueMove 3 optical sensor offers one-to-one raw tracking, meaning the distance the sensor moves on your desktop is mirrored exactly on the screen, with as little processing involved as possible – therefore no lag.

We rather like the Rival's understated approach to design; all we get here is the SteelSeries logo lit up on the back, surrounded by matte black plastic. Light also leaks out from around the thick, grippy wheel, which has enough click to it that you're left in no doubt as to whether it has gone round a notch or not. Fibre-reinforced plastic helps bring the weight down to a mere 88.3g, too.

The grey silicon side grips are grippy, and the main buttons clicky – they're

separate from one another and the rest of the body, and made from the same fingerprint-repelling plastic, which is slightly textured. They're very pleasant places for your fingertips to hang out, as long as you're right-handed.

Underneath are Omron-designed switches rated for 50 million clicks, and the restrained lighting does all the usual Prism-enabled tricks across your peripherals, the software up to SteelSeries's usual standards, and the 32-bit CPU onboard showing no signs of slowing anything down.

With its new sensor and complete failure to put a foot wrong, the new Rival is a mouse to watch.

Verdict

At a more wallet-friendly price, this lightweight mouse keeps things simple and clean.



\$79 | WWW.TTESPORTS.COM

Sensor: 12,000dpi optical (Pixart PMW 3360); Design: right-handed, 6 buttons; Cable: 1.8m; Dimensions: 12.8 x 7.1 x 4.3cm; 140g

Thermaltake Ventus X Optical

No sweat.

As nice as powdery plastic is to the touch, it can get pretty uncomfortable cocooned inside your fist during an extended gaming session.

Thermaltake's Ventus X RGB optical gaming mouse is taking hand heat head-on with a hollow honeycomb lattice mouse frame to allow airflow to your palm, keeping it cool during long gaming sessions. While we were naturally a little disappointed that there wasn't also a fan in there, the hollow centre allows more than enough air through to keep your hand cool and mitigates a real thermal problem in some of today's best gaming mice.

In addition to the hoof, the Ventus X has a pretty common button rollout including a notched scroll wheel, a profile/ DPI sensitivity trigger and two nicely placed thumb buttons. The Ventus X RGB has been sculpted for right-handers with a soft rubber mats lining the curved

edges where your digits grip. There isn't much in the way of customisable buttons included, but there is a weight hatch in the bottom that has three removable 4.5g modules that can be removed as increments or in their entirety.

Thermaltake has a number of keyboards without software, so we were surprised to see that the Ventus X RGB includes support from a TT eSports Command Center app. It's clear that software isn't this manufacturer's strong suit, but the app includes all the RGB lighting options, DPI settings and profiles you'd expect, but it also includes some advanced features like the sensor lift off height, angle snapping and trigger response time.

Verdict

A nicely weighted right-handed mouse that has everything you need and keeps things cool.





Changing your tunes

Give your games an audio upgrade with a punchy new headset. Lindsay Handmer tests nine options.

\$80 | WWW.ASUS.COM/AU

53mm drivers; Frequency response: 20-20,000Hz; Removeable mic

ASUS Cerberus V2

Offering up affordable quality.

For those who like to play games a lot, a good headset is an essential bit of kit. It's a must-have for LANing, but it also helps to avoid disrupting (or, ultimately, being distracted by) family and friends.

What's more, even if you don't intend to use the microphone for voice chat, gaming headsets are often pretty good value compared to over-the-ear style headphones. Of course, they aren't perfect, and tend to be focused towards immersive bass and clear voice, rather than perfectly recreating music.

For this month's PC Gaming Annual, we've gathered up nine recent models and put them through their paces, with prices ranging from the very affordable right up to the high end. Gaming headsets can be wired and wireless, though wired is often preferred for quality, reliability and, of course, price. Most headsets are stereo, but there are also models with virtual (as well as multi-driver) surround sound. They aren't just for PC gaming either, and many of the tested include adaptors for use with consoles, smartphones and tablets.

There are some key features to look out for when comparing headsets. Some have retractable, or removable microphones (and even secondary mics within the inline controls) which makes them a little sleeker when using as headphones. We love models with pivoting earcups for extra comfort, as well as swappable padding for customised comfort. Inline controls make it very easy to physically adjust volume or mute your mic – though some models put the controls on the headset itself, which can be easier to use. Comfort can be subjective, but we find that headsets with large ear cups, and a self-adjusting bridge head support design tend to suit a large range of people.

Easily found for under \$100, and as little as \$79, the ASUS Cerberus is aimed squarely at those who want decent quality and features without blowing the budget. The headset is wired, and uses the standard over the ear style cups. It's available in blue, red or green, and can be matched with a range of other Cerberus gaming products. The headset features large 53mm drivers, with a 32 Ohm impedance, and a 20 – 20,000Hz frequency response.

The Cerberus has a fixed 1.2m braided cable with inline volume and mic mute, with a single 3.5mm jack on the end. For use across other devices, it also has a splitter / extension cable, with the typical dual 3.5mm ends. The adjustable microphone is removable, but in a move we love, ASUS has also included another mic on the inline volume controls. This makes it easy to use the headset as a hands free

alternative for your phone, without the boom.

With very large ear pads, and a self-adjusting head strap, the Cerberus is very comfortable, though a touch tight. It also features pivoting ear cups, which help it sit very evenly. Noise isolation is excellent, and headset has plenty of bass, and a surprisingly rich mid-range, but lacks slightly in the high end. The microphone is very easily positioned, and was more than up to the task of voice chat. The Cerberus uses a combination of metal and plastic, and while it can't fold flat, it's quite robust and will happily handle being thrown in a bag.

Verdict

Great audio quality and a very useful set of features at a very appealing price point.





\$360 | WWW.ASUS.COM/AU
7.1 surround sound; 5 x drivers per ear; Control Hub

ASUS RoG Centurion

Wireless headset at a high price.

For those who want the best, the ASUS RoG Centurion offers true 7.1 surround sound and just about every high-end feature you can image, albeit for an eye-watering \$360. The headset is wired, but uses a USB connection, out to a very in-depth control hub. Not relying on virtual surround, the Centurion has five drivers (including a subwoofer) in each ear. It also uses a hi-fi grade headphone amplifier to ensure stellar results.

Despite being very large, and weighing a hefty 450g, the Centurion sits very comfortably, and even comes with different earpads for customised comfort. The headset uses ASUS's Sonic Studio, which gives a huge range of customisation for those who like to fine tune their listening experience. While some of the deeper adjustments take a little time to get used to, generally it's very well laid out and easy for beginners.

The physical control hub adds another layer, with the ability to tweak the most important settings quickly. The result is surround sound that is very noticeably superior to virtual options, with excellent positional audio. The sound quality itself can be tricky to compare, as it can be adapted so readily, but overall the Centurion has great bass kick, with strong midrange, and crisp highs. The (detachable) microphone quality is also top notch, and the software does an excellent job at cancelling out environmental noise.

The RoG Centurion also incorporates a little bling, with controllable RGB LEDs and a handy stand to store the headset when not in use.

Verdict

Easily living up to the price, the ASUS ROG Centurion offers an audio experience like no other.



\$99 | WWW.COUGARGAMING.COM
7.1 virtual surround sound; 50mm drivers; RGB LEDs

Cougar Immersa Pro

Is virtual surround sound worth it?

Even cramming multiple drivers into a headset can't replicate room-scale surround sound, but the virtual alternatives give many of the advantages for a fraction of the cost. The USB-powered Cougar Immersa Pro uses standard 50mm drivers, and provides immersive audio via the UIX System software.

The available options are quite thorough, including a range of presets, and a full equaliser. The software also allows control over the RGB LEDs in the headset ear cups, including five different effects. In a move we love, the Immersa Pro is modular, separating the USB amplifier and the headset, which uses standard 3.5mm plugs. This means you can use it with other devices, or even use the USB module with another headset. A very intuitive dial on each earcup is used instead of online controls, to adjust volume or mute the mic.

The Immersa Pro uses robust metal rods for strength, with a self-adjusting headband that helps make it very comfortable. Noise isolation and bass are excellent, and while the midrange is warm and full, the highs lack a little clarity. The 7.1 surround sound is well implemented, and gives a roomy feel to gaming, while also providing decent positional audio. The slide out microphone is more than up to the job, but can't be stuck away as neatly as the competition.

For those who don't want the 7.1 surround sound, (or a few other features), the trimmed back non Pro version of the Immersa is worth a look at just \$60.

Verdict

The Immersa Pro offers high end features and sound quality without going overboard on price.





✓✓✓
apc
RECOMMENDS

\$90 | WWW.GAMING.LOGITECH.COM/EN-AU
Detachable mic; 40mm drivers; Dual removable cables

Logitech G233

Flexible yet affordable.

For savvy online shoppers, the Logitech G233 can be picked up for under \$90, which puts it right in the middle of the range tested. The headset is wired only, but uses a removable cable and comes with both a dual and single 3.5mm cable, and inline controls. This means the G233 can be used with a PC, console or smartphone, for flexible gaming audio.

The Logitech headset uses large mesh covered pads that sit entirely over the ear, and are removable for cleaning. The ear pads also rotate, so can be folded flatter into your gaming bag. Combined with the padded and adjustable headband, comfort is excellent, and the headset is not too tight on a large head. For those who like marathon gaming sessions, the headset is also fairly light at 259 grams. The microphone is detachable, so the G233 can be used as headphones without looking out of place. The mobile version of the

cable even has a microphone, so the G233 can still be used for making calls when paired with a smartphone.

The G233 uses typical 40mm drivers rated at 32 Ohms, and with a 20 – 20,000 Hz frequency response. Thanks in part to the excellent noise isolation, the headset packs a decent amount of bass, with nice clarity in the mid-range, and slightly anemic highs. Still, overall the sound quality is great, and the G233 handles both gaming and music well. The microphone recorded crisp audio, and is well set up for voice chat.

Verdict

An above average all-rounder wired headset from a trusted name.



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apc
RECOMMENDS

\$130 | WWW.RAZERZONE.COM
Dual 50mm drivers; Frequency response: 12 – 28,000Hz; Virtual 7.1 surround sound

Razer Kraken 7.1 V2

Who wants surround sound?

Unlike some of the more expensive headsets, the Razer Kraken uses virtual surround sound. That's not to say it isn't effective, but under the sleek shell are two quite normal 50mm drivers. On the plus side, the Kraken is quite affordable and there is a normal stereo 'Pro' model that is otherwise the same, for \$15 cheaper. The Razer Kraken uses large, oval, over the ear style pads, and handily, they are also interchangeable with some optional varieties available. The microphone partially retracts into the left side and the position can be adjusted.

The Kraken 7.1 connects to a computer (Mac or Windows) or PS4 via USB, but does not have a 3.5mm option. The surround sound effects (as well as the overall headset management) is done via Razer's excellent Synapse 2.0 software (PC only). In use, the virtual 7.1 sound

isn't as good as those with individual drivers, but after some tweaking is remarkably effective. The headset has a better-than-most 12 – 28,000Hz frequency response, and impressively crisp mid and high ranges, while still packing some punch in the bass. The headset isn't ideal for music, but fiddle with the software profiles and you'll reap fine results. The microphone got the job done, but didn't wow us. The Kraken is a big headset, and weighs in at a heavy 346g. Still, it's quite comfortable to wear, even for longer sessions.

Available in black, gunmetal grey and white, it includes customisable RGB LEDs in each side for some added character.

Verdict

Very effective virtual surround sound for those willing to play with the software profiles.





\$60 | WWW.ROCCAT.ORG

50mm drivers; Frequency response: 20 – 20,000Hz; Open-ear design

Roccat Renga

Gaming audio on a budget.

Priced as low as \$50, the Roccat Renga is one of the more affordable

headsets we tested. It uses a fairly classic, if somewhat basic design, with a 2.5m cable and dual 3.5mm jacks. The headset itself has large 50mm drivers, with thin but wide over-the-ear-style pads. Rather than being fully enclosed, the Renga has gaps between the earpads and the drivers. This makes it an open design, where it is easier to hear external noise, and is typically a little bit cooler in use.

Keeping everything mounted in place is an expanding bridge design, with strong but flexible metal supports. The result is a tough but flexible headset that is very comfortable to wear. The Renga drivers offer a standard 20 – 20,000 Hz frequency response and a 32 Ohm impedance. While open design robs the bass of some of its kick, the mid and high ranges are quite clear. Cable noise is mercifully

low, and you'll still be able to keep tabs on what's going on around you. Audio from the mic is excellent, despite it being a little stiff to position perfectly, and is a typical swing-down boom-style with an adjustable end.

While this isn't a headset you'd choose to listen to music, the Renga gives better than expected gaming performance considering the price. The Renga includes an inline volume and mic mute control, and has a dual 3.5mm to single 3.5mm adaptor for use on varied gaming setups.

Verdict

A competent but not awe-inspiring open-ear headset for those on a budget.



\$120 | WWW.TTESPORTS.COM

Virtual 7.1 surround sound; 50mm drivers; RGB LEDs

Tt eSports CRONOS Riing RGB 7.1

Give yourself a competitive edge.

By ditching the typical 3.5mm jacks and opting for USB, the Tt eSports CRONOS Riing can incorporate virtual 7.1 surround sound. The inbuilt amplifier handles up to 96KHz, 24-bit audio, and uses dual 50mm drivers that are tilted to give your ears a little more space. They offer the typical 32 Ohm impedance, and a 20 – 20,000 Hz frequency response.

The inbuilt amp in the CRONOS is on par with most motherboard audio, and the headset provides plenty of low-down kick, strong mids and a slightly flat higher end. The virtual surround sound definitely adds an immersive element to gaming, and performed reasonably well in conveying spatial information. Sound isolation is above average, and there is little cable and movement noise. The CRONOS uses a slide out microphone, which is easily positioned, but feels a little

flimsy. On the plus side, it records excellent audio.

The CRONOS uses chunky over the ear style pads, with a self-adjusting head strap for support. It's very comfortable thanks to pivoting ear cups, and lighter than it looks. The headset can also fold flat for easier transport in a gaming bag.

What's smart is how the inline remote control toggles surround sound, volume and equaliser presets, and mutes the mic. Most of the setup and tweaking is done via the included software, which has loads of presets, as well as manual controls. The headset also includes RGB LEDs in the ear cups and inline remote, with eight different lighting effects.

Verdict

An above-average headset for the price, with the bonus of immersive 7.1 surround sound.





\$80 | WWW.TTESPORTS.COM

40mm drivers; RGB LED lighting; Fold down mic



\$60 | WWW.ANYWARE.COM.AU

50mm drivers; RGB LEDs; Integrated mic

Tt eSports Shock Pro RGB

Stand out from the crowd.

Priced at just \$80, the Thermaltake built Shock Pro RGB is a fairly affordable headset. As expected at this price, it's wired with a 2m braided cable that can't be removed. A 'Y' cable 2-in-1 converter is included so the headset can be used with a console or mobile device, as well as your PC.

The Shock Pro uses 40mm drivers, with a 32 Ohm impedance and the normal 20 – 20,000 Hz frequency response. The headset sits entirely over the ear, and provides great sound isolation and bass. Mid and highs are reasonable, but get a little muddy at higher volume and suit gaming more than music. The fold down mic is well positioned (but not very adjustable), and handles voice chat with aplomb. We found the headset slightly tight on a large noggin, but thanks to the 25mm thick ear pads and self-adjusting support strap, still quite comfortable. The headset is

light considering the bulk, but feels robust enough to handle being shoved into a bag regularly.

Rather than placing them on the cable, the Shock Pro mounts the volume and mic on/off button controls on the left side of the headset. We actually prefer this, as it makes it easy to quickly make adjustments with the left thumb, and never have to take a hand off the mouse.

The Shock Pro's party piece is an array of RGB LEDs on each side, with seven different user selectable colours and two lighting effects – colour jumping pulse, and single colour pulse.

Verdict

Comfortable, colourful and plenty of bang for gaming audio buck.



Promate Valiant

Is it worth saving money?

Aimed at those on a budget, the Promate Valiant is available for under \$60. The headset looks the part, sporting a chunky over the ear style, metal headband and self-adjusting support strap. It's also available in black or white. While relatively solid, the Valiant is built quite lightly, and is missing a few bells and whistles compared to the competition.

For a start, the microphone is integrated into the left earcup, and while sensitive enough, does not provide the same clarity as a boom mic. Sound isolation is decent, but the design means a lot of cable / movement noise, and it's loud, too. Sound is provided by dual 50mm drivers, with a 20 – 20,000Hz frequency response.

While providing a nice full sound with plenty of bass well-suited to gaming, the Valiant lacks precision in the mids and highs when listening to music. At least

it's comfy to wear.

The Valiant includes a single 3.5mm input, but no splitter, so can't be used out of the box with all gaming setups. The non-removable cable is long at 2.5m, and a volume control wheel is incorporated into one earpad. The headset includes a USB plug, but it's not actually for audio. Instead, it powers RGB LEDs in each earpad, though they just cycle and fade between colours and can't be controlled.

For the price, the Promate Valiant is fair at best, but doesn't exactly stand out from the crowd.

Verdict

Affordable and comfortable, but fairly bare bones.



Gaming headset quick setup guide

In general, using a gaming headset can be quite simple – plug it in, put it on your head and off you go.

But there are still plenty of issues that can crop up, and ways to get a little more from your headset. It will vary from headset to headset, but it's important to position your microphone correctly, if adjustable. The tip of the mic should be positioned a few centimeters away from the corner of your mouth, and out of the way of airflow when you're breathing. Make sure the microphone hole on the end of the boom is aimed roughly at the middle of your mouth. Cables rubbing on clothing or a desk can introduce distracting noise, so many headsets include a clip (often on the controls) to help stop any movement.

WINDOWS CONFIGURATION

Once plugged in, it's worth checking your Windows audio configuration and not just rely on any included software. Head to Control Panel > Sound (or right click the speaker icon and select 'Playback Devices') and you should see your headset listed. Select your headset and then 'Configure', making sure to check the stereo or surround sound channels are working correctly. Under Properties there are a range of options, such as level adjustments and, depending on your soundcard, enhancements. Back under the 'Sound' panel, selecting the 'Recording' tab, then selecting your headset, allows you to test and configure your microphone. Some specific software (such as for voice chat, your sound card or for your USB headset) may have its own range of configuration options, so check them as well.

GAME FOCUSED TWEAKING

Every game emphasises different audio aspects – maybe you need to hear light footsteps, or just want immersive, skull-rattling bass every time there is an explosion. For those with surround sound, double check that it's enabled in the game, not just the headset software. It can also be somewhat of a subjective experience, so play with the settings to find what works best for you. Gamers looking to hear tiny noises, or directional sound, should wind back the bass a little to help make sure no details are lost.

TROUBLESHOOTING

Flakey headsets can be frustrating, but there are usually simple fixes. Double check it's plugged in correctly, and test on different devices in case it's your sound card having problems. For USB headsets, fully remove and reinstall any drivers, as well as testing on another USB port, or computer. For mic issues, don't forget to check the mute button is turned off.

Beware though of damaged cables, which often result in intermittent or no audio. Check the cable for physical damage, and try twisting it in different directions while in use to try and isolate the problem section. Don't despair though as it is possible to get damaged cables repaired – ask at your local computer shop. As for existing headsets, the padded ear cups typically eventually get too hard to clean, or start to wear out. Check on eBay.com.au before giving up, as many popular headsets aftermarket replacements available, offering different comfort levels.

Some headsets can fold flat, making it easier to slip them into a bag when on the go.



"Every game emphasises different audio aspects – maybe you need to hear light footsteps, or just want immersive, skull rattling bass every time there is an explosion."



Many headsets come with their own software which can include presets for getting the best sound in different games.



Before giving up on a well-used gaming headset, check for replacement earpads on eBay.



A range of plug options are often bundled with headsets for compatible gaming on PC, console or mobile device.

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Stream everything

Alex Cox explains how to get your digital experiences wherever you need them — whether its your games, your media, your desktop, or even your life.

We've relied on end-to-end streaming for longer than we've relied on computers. Where would society be without the influence of radio or cable TV? Would we be quite the same if Major General George O Squier hadn't developed Muzak's earliest tech, a 1930s system of sending inoffensive music along electrical wires directly to elevators and stores? Well, probably. We might even be slightly more sane. But that's not the point: Streaming has long been hugely important, and the internet has completely democratised it.

You're now free to send whatever you want wherever you want. You can push data, making it available to anyone who

wants it, or pull streams, just for you, from a private source. You can work with audio, video, live cameras, or any other data that suits. You can use streaming for entertainment, for profit, or for practical benefits. And you can do it all, for the most part, for free. All you need is a quality broadband connection on either end of the streaming path. You might not even need that, if your server hardware is robust enough to transcode media on the fly, converting it to a lower resolution that reduces bandwidth demands.

In this feature, we take you through as many different content streaming situations as possible, from games to sounds, and beyond. It's all very situational and personal. Everything

you might want to stream has slightly different methodology, unique software and technical considerations to take into account. Many of the tools we talk about can be used for more than one thing, and the specific one you use is, at the end of the day, up to you.

We talk public and private streaming, and give a few suggestions as to how to take advantage of the former to increase your online profile. While it's going to take a lot of work and a special kind of charisma to top Twitch's 200,000-viewer record for a single streamer — and, indeed, its all-time stream record of over 1,000,000 for a CS:GO tournament match — there's nothing stopping you from trying.

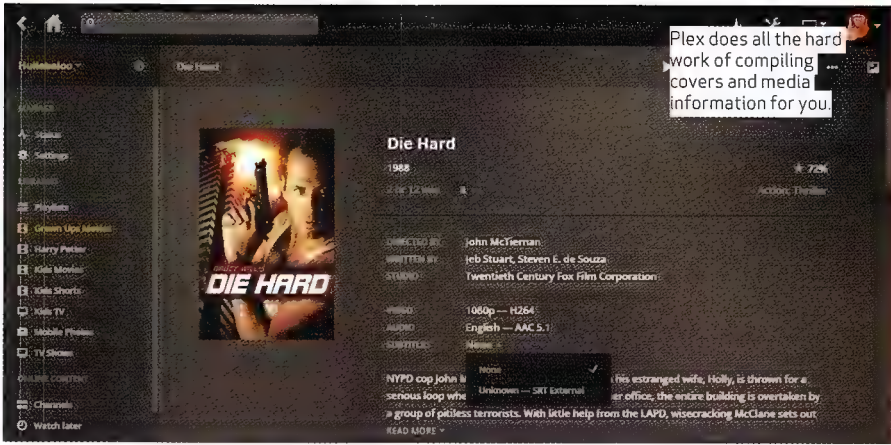
MEDIA LIBRARY STREAMING

Right off the bat, Plex Media Server is, by far, the slickest and cleanest solution for getting video and audio content that you own from a personal server on to basically any device anywhere in the world. Originally developed as a fork of XBMC (now Kodi), Plex has, over the past nine years, evolved into an extremely capable media host, which can look after everything from your music to your video content and — even, if you sign up for the monthly Plex Pass service — serve as a backup method for critical files such as photos. It offers apps for every major games console, and for mobile phones and tablets, includes compatibility with the Google Chromecast and Amazon Fire Stick, and has a fully-featured web interface for everything else. The server itself can run on a number of devices — you may even be able to get it going on your NAS — but we recommend something solid. Check the 'Right Hardware' box opposite to see the kind of gear you should be aiming for to get maximum performance.

Getting it set up is simple. Grab the appropriate installer for your device from plex.tv/downloads and run it. It's a straightforward installer, no surprises. When it's over, you have to run through a bit of first-time setup in a browser window. This basically just involves creating an account on the **Plex.tv** website — Plex handles online translation and routing for you, which makes for vastly simplified remote streaming — and running through a few self-explanatory steps, including setting up a folder for your media. This can reside, realistically, wherever you'd like, although it's most efficient to use a drive directly connected to the computer that's running the server, because pulling from network storage in order to send media via the network doubles up the bandwidth required — unless you opt for the cloud option (part of the Premium package), which accesses content on storage providers such as Dropbox and Google Drive, and doesn't require a server PC at all.

With everything in place, you have access to your entire media library from anywhere. Just sign into the Plex client, on any device, with the credentials you set earlier, or head to plex.tv/web in a browser window. If your files are named correctly (see bit.ly/1Rxx8Ca), the server polls sites such as The Movie Database, Last.fm, and TheTVDB for thumbnails, episode information, and even trailers, and automatically arranges your media. Honestly, it's ridiculously easy and compatible with just about every format — the most difficult thing you have to do is collect together and rip your media.

In theory, you have other choices if you're already tied into a different



ecosystem. You could, with a bit of fiddling with SSH and VPN tunneling, make a Kodi library available online, or use VLC (videolan.org) to stream any kind of media locally. Alternatively, PlexBMC (bit.ly/2gCxAvq) can funnel the contents of a Plex media server into a Kodi client. Subsonic (subsonic.org) was designed solely for audio streaming, but also includes rudimentary video streaming capabilities, and works in a very similar way to Plex. And, hey, if you're happy to forget about controlling precisely what you can watch, you could always eliminate the worry of compiling a media library, and sign up for a dedicated streaming service such as Spotify, Netflix, Amazon Prime, et al.

DESKTOP STREAMING

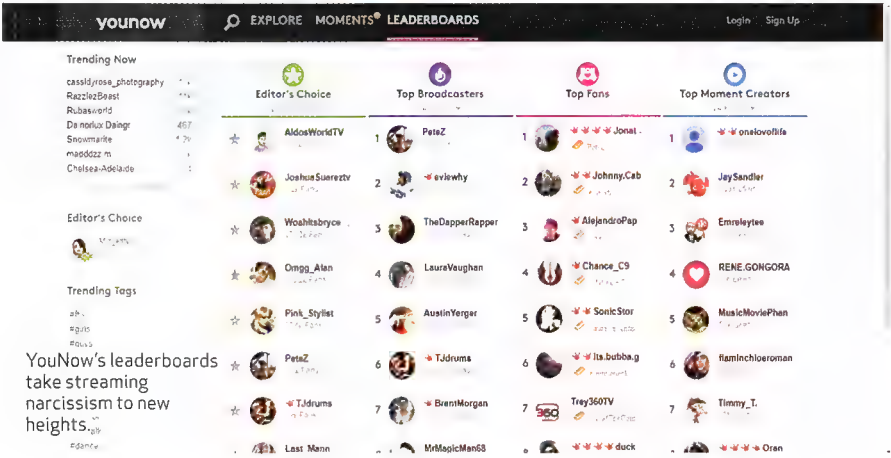
Now for something more practical: remote controlling your PC. There are several easy options for taking your desktop on the road, many of which have been around for a long time. VNC, for instance, is a well-seasoned open-source remote desktop client, highly configurable, with several different (but compatible) spins. Try TightVNC (tightvnc.com) or RealVNC (realvnc.com) if you're leaning in this direction; run the server app on the machine you want to access, and set a strong password — VNC's ports are, given that they offer up full access to your PC,

often targeted by rogues.

Windows has a desktop streaming tool included in the form of Microsoft Remote Desktop, which can pick out individual apps from your desktop and stream them seamlessly without the rest of it, and has client apps for phones and other operating systems. It's well featured and rather good, but it's not our top pick. We're leaning toward something that, like Plex, does all the hard work for you: TeamViewer (teamviewer.com). It may be the most attractive among these tools in terms of the ease of its interface, and it's generally used for idiot-proof remote support purposes, but it's entirely feasible to set it up for easy access to your own hardware.

When you've downloaded and run its installer, select 'Unattended'. Now, when you first run TeamViewer, you're given a wizard to run through; you don't need to sign up for an account, you can use it anonymously if you choose. Note down the ID number you're given at the end of the process, and you can use it in conjunction with the password you set earlier to gain access to your desktop at any time, by using a TeamViewer app or through the website. The app also shows another password; it changes every boot, and you can give this to folks you want to be able to access your machine without knowing your login details.

One thing to note: Streaming your





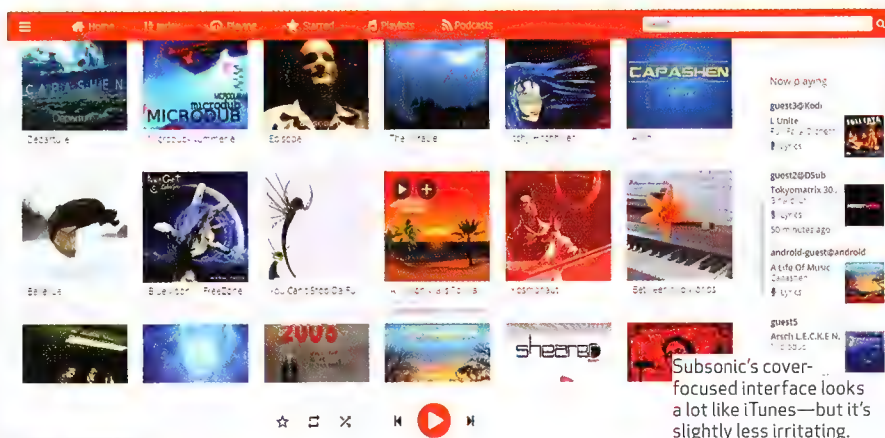
The right hardware

Streaming isn't usually very gentle on your hardware

Transcoding or encoding a video stream puts strain on your CPU, your GPU and your RAM, so if you're looking for a smooth experience for your viewers, you should go as big as you possibly can to negate the overheads of putting that content online. Machines with more cores and threads tend to handle the task much better. Dedicate a machine to streaming if you can; use a device such as the Avermedia ExtremeCap U3 to pull in a 1080p signal over USB 3.0, then feel free to tax the machine you're creating content on, without fear of dropped frames.

That said, the most important asset of a good streaming machine is availability. If you're not performing otherwise demanding tasks — say, if you're only streaming your media collection — you can get away with a lot less, as long as your server is powered up and ready to go precisely when you need it. The best hosting hardware in this case is low-powered, low-noise, and able to be left switched on at all times. A specced-up Intel NUC, an old desktop tucked in an inconspicuous corner, an unloved laptop with its screen turned off, just about anything will do — and a cloud option, such as Plex, could be even better.

Regardless of whether you're streaming to one or to many, your server needs a quality network connection. Don't feel you'll be able to rely entirely on wireless, because high-res video puts big bandwidth demands on your hardware, and shaky connections, naturally, affect performance, so wire it up via Ethernet to a strong broadband pipe if you can. Avoid powerline Ethernet — we've found it has a tendency to go up and down at random — and opt for an internet package with as much upload bandwidth as possible. It sounds obvious, but some just have the ratio all wrong.



Subsonic's cover-focused interface looks a lot like iTunes—but it's slightly less irritating.

desktop is generally more demanding, and slower, than streaming AV media, because your videos and audio have been encoded to reduce size and required bandwidth. TeamViewer and its ilk usually do some work to negate this, such as blanking your desktop background, dropping the colour depth, and compressing the stream on the fly, but this increases sluggishness. If you're trying to throw the raw contents of a 4K desktop down your internet connection, don't expect to comfortably run graphically demanding applications, or for the experience to be the same as being sat at your desk.

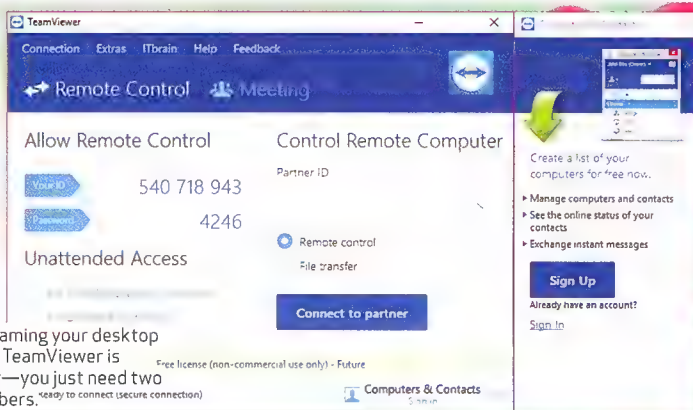
If you want pinpoint control over the minutiae of your desktop streaming, there's another option: VLC media player. Set up a server by opening your desktop as a capture device and switch from Play mode to Stream mode. Run through the wizard that appears, select the destination IP address of your stream and use port 1234. You can now select the exact compression method you want to package your stream in, from encapsulation to video and audio codecs, by clicking the tool icon. It's a one-way street, so you can't take control with VLC itself, but it's an option.

GAME STREAMING

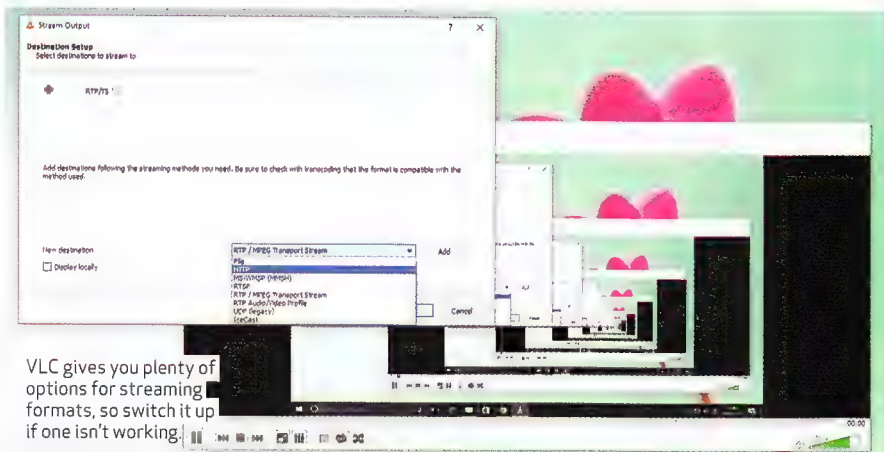
Games are the gaudy poster child of live streaming, and the topic most

associated with the phrase. Given its proliferation, there are plenty of technologies and services associated with transporting gameplay from one place to another. If you're keeping it to yourself, look in the direction of Steam's In-Home Streaming service which, with the minimum of effort, translates titles running on a powerful gaming PC into an h.264 stream, and fires them off to a client machine. As long as it's running Steam, this client can be equipped with almost any hardware — bringing beautiful games to the wimpiest laptop — though there are caveats to consider on the server end.

You need a machine powerful enough to render your game and quickly compress a video stream at the same time. Your server resolution is the maximum that is replicated on your client, and that server needs to be actively running the game, so it can't be used for anything else while you're streaming. There's a small amount of lag, naturally, and while it's technically possible to use VPN trickery to run In-Home Streaming out-of-home, the additional delay makes your games all but unplayable. The same things are generally true for other stream playing experiences, such as Nvidia's Gamestream, which puts your GeForce-accelerated games on to Nvidia Shield devices, and third-party game streamers, such as Parsec and Remotr.



Streaming your desktop with TeamViewer is easy—you just need two numbers.



VLC gives you plenty of options for streaming formats, so switch it up if one isn't working.

"Games are the gaudy poster child of live streaming, and the topic most associated with the phrase."

Game streaming comes into its own with one-to-many solutions, such as Twitch and YouTube Live, which take a stream from a client app — OBS is complex but free, XSplit comfortable but subscription-based, and Gameshow the new paid-for pretender — and send it online for anyone to enjoy. Microsoft is, as Microsoft does, sticking its own fingers in the pie, with Mixer (formerly Beam), which has the advantage of being built into Windows 10 from the Creator's Update onward, and available from the Game bar, but the disadvantage of being, frankly, not very good. It'll grow, and it'll get better, but stick with the big boys for now.

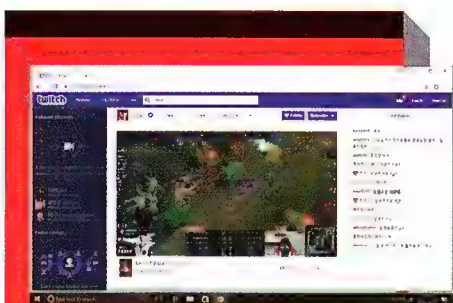
A few technical considerations: While it's possible to stream to the internet from the PC you're playing on, that's often not the best idea. You're dealing with, potentially, far greater system overheads than in-home streaming, because you probably also want to process a video stream of your webcam and some sort of flashy overlay. Bigger streamers tend to split the load, with one machine managing the

gameplay portion, and another equipped with an HDMI capture device and running the stream end, putting viewer interaction front and centre.

PERSONAL STREAMING

While Twitch has long been the home of game streaming, it's recently taken a turn toward the personal, in the form of Twitch IRL channels. These move the focus away from games and on to the streamer, allowing for personal, often inane, vlog-style live streaming. Twitch's terms of service require that these include viewer interaction, follow strict guidelines, and don't deviate too far from the streamer as the focus; the service also runs a talk show category, which caters for more subject-focused content.

YouTube Live, accessible from its Creator Studio, is more flexible in terms of subject matter — you're free to stream whatever you like, as long as you don't offend any copyright holders — and includes lots of useful tools. Sign up with your Google account, and you are given a livestreaming permalink that



Stream into the big time

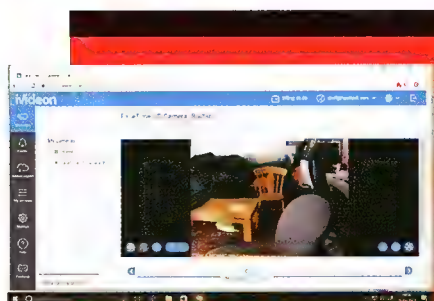
There are a lucky few out there who manage to make money from streaming.

Only a few, though, so we don't recommend quitting your job just yet. It's hard to say what the prevailing source of income is for the average streamer; some make the bulk of their cash from tips and donations, which are often tied to shoutouts and on-screen recognition. This can work well, particularly for streamers with a growing audience, although those on the lower rungs often find this isn't enough to constitute a wage. A few also push Patreon subscriptions, although that's a system more associated with episodic content.

The key to making a living from streaming really seems to be the Twitch partner program, a mildly exclusive club reserved for regular streamers with a growing audience. You need to apply to join, and you absolutely must behave in terms of copyright, but when you're on the train, you share half of each US\$4.99 monthly subscription to your channel. Amazon's ownership of Twitch also helps; Amazon Prime subscribers get one subscription included with their account, so dedicated viewers may even be able to chip in (virtually) for free.

Getting to the peak, though? Aside from luck, there are a few key things to consider no matter what you're streaming. Be consistent with your schedule and quality. Be pleasant, approachable, and civil. Interact with your chat without scaring people away. Make sure your content is accessible — break it into manageable chunks on YouTube, and archive your broadcasts. Keep your image and audio quality high. Make friends with other streamers; they may host your channel when they are offline, which can drive attractive traffic your way. And, if you can stand it, pick a popular topic. Certain games do better than others — check Twitch for specifics. And, well, it also helps if you're highly attractive.





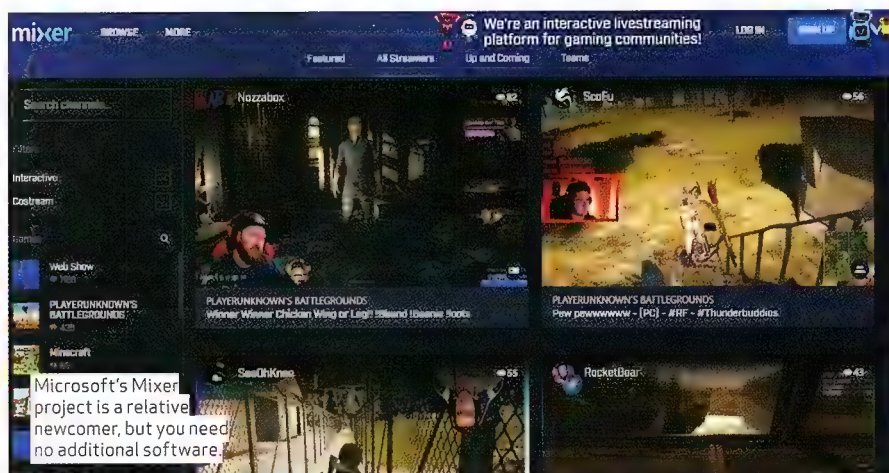
Security camera streaming

You likely have a bundle of old cell phones or tablets hanging around, or can get your hands on some.

So here's a little bonus streaming idea. Set one up as a security camera, and beam the goings-on of your household to wherever you happen to be. It may take a bit of creative mounting and wiring to put them in place, though the Dockern mobile wall mount (\$15) may be all that you need.

The software side of things is actually remarkably easy; grab IP Webcam (Android, free) or iVideon (iOS, free) from your device's app store, run the app, point the phone's camera at the thing you want to watch, and install the appropriate client on your PC. VLC's stream capture function is enough for IP Webcam, while iVideon asks for its own server, downloadable from ivideon.com/get/.

That's only the tip of the iceberg, though. With multiple mobile cameras, standard webcams — which you could hook up to any old streaming box with little overhead — or dedicated IP cameras, you can set up multiple simultaneous streams to a multi-cam server, such as the aforementioned iVideon or iSpy (ispyconnect.com). iSpy records footage to a hard drive, triggers itself with customisable levels of motion detection, and even alerts you to intrusions with a private video uploaded to YouTube. A subscription (from \$10 per month) gets you access to your security camera network online, although there's nothing to stop you getting a little creative; why not stream your local cam server online using something like TeamViewer, for instance? It's absolutely less convenient, but a damn sight cheaper. Alternatively, you could always revert to iVideon, which gets you online access with limited features on its free plan, or more if you want to expand your coverage for a fee.



"Twitch has a Creative category, which permits art, coding, music, and, occasionally, classic Bob Ross and Mr Rogers shows."

you can share with potential viewers, and (with the help of OBS or similar) you'll soon be broadcasting. There's an included DVR feature, which lets viewers who missed the beginning of your broadcast jump back up to four hours. You can also stream directly from your phone, as long as you have an adequate mobile connection and data plan.

There's a number of options for those who desire a more intimate audience. Facebook Live is growing in popularity, and getting up and running is as simple as penning a status, then hitting the live video option. You can, as with any Facebook post, set your privacy to public, and this is certainly a good option if you're using the broadcast functionality to push your brand, but bear in mind that you'll need to publicise public events if you want them to reach beyond your timeline. Justin.tv-style livecasting networks still exist, too; Ustream has been swallowed up by IBM, and now aims toward the

corporate sector, but YouNow is increasingly popular, though it can lean toward Chatroulette and Omegle territory at times, and that's not somewhere any civilised person wants to be. If you want to share a hobby rather than your personality, there are other niche streaming services. Twitch has a Creative category, which permits art, coding, music and, occasionally, classic Bob Ross and Mr Rogers shows, although you wouldn't get away with broadcasting these yourself unless you're the rights holder. **Picarto.tv** caters specifically to artists, and has a long history and large community behind it. We should also mention Mixlr, which is perfect for audio streamers; you can use it to set up a virtual radio station or create a live podcast recorded for later. It's not free — a full subscription with a permanent livestream URL will run you a cool US\$499 per year — but you can test it out with a trial. Happy streaming! ■



Pick up art tips or showcase your talents for drawing scantily-clad anime girls on Picarto.

Dive into a World full of Creativity!



ALL ABOUT USB

Over 10 billion sold, and counting.
Chris Lloyd reveals how USB changed everything.

It has been calculated that there are, on average, 13 Universal Serial Bus ports within 30 feet of you right now — amazing. USB first appeared on PCs around 1996, and has done very well ever since. By the new century, it was everywhere. USB ports are on cameras, cell phones, MP3 players, printers, and in your car. Everywhere. It has, indeed, almost become universal. Is there really an average of 13 ports around you? No idea — we made that up, but it sounded believable, didn't it?

Why has USB become so successful? Well, the original technical specs were reasonable for the period. Sockets and plugs are simple and therefore cheap. It

includes power — enough to drive a small device or charge a larger one. You can plug things in and out at will, something we've got so used to now that we forget we used to have to reboot a lot to get things working. It has another vital ingredient of many successful standards: no royalty payments. If you want to use the official logos on your gear, you must get it past the compliance testing and pay a small fee. That's it — you don't have to pay a kickback on every USB device you sell. Lastly, there's the mess that it replaced.

In the early '90s, most peripherals had their own connection. Your keyboard had a chunky IBM AT five-pin plug, the mouse wanted a nine-pin serial port, the

printer its own 25-pin parallel port. The newfangled modem required an RS-232 serial port. SCSI drives needed a SCSI port. IBM's PS/2 keyboard and mouse ports were neater, but were essentially just smaller versions of the existing ports. The proliferation of standards made coding difficult, and added lots of ungainly sockets to motherboards. If you developed a new peripheral, where would you plug it in? The world was rapidly digitising, and the average computer had no suitable free ports to plug anything new into. Peripherals often resorted to shipping with their own expansion card to carry the port they needed.

USB was to be a single high-speed standard to connect all external devices. Work started in 1994, and seven big players got together to hammer out the details – Intel, IBM, DEC, Compaq, NEC, Nortel, and Microsoft, with Intel's star techie Ajay Bhatt playing a key role. The first USB silicon appeared in 1995. By the following January, standards were agreed, and it was rolled out on PCs. When support was added into Windows 95 OSR 2, it began to proliferate. By 1998, it was established enough for systems to start dropping the old ports altogether – Apple was first, of course. By the time USB 2.0 came along in 2000, it was an unqualified success. That year also saw the first USB flash drive from IBM (or memory stick, or pen drive, or thumb drive, or a multitude of other names), all 8MB of it. Today, the USB standard is overseen by the USB Implementers Forum, a non-profit organisation founded by many of the same people behind the original specifications.

USB consists of two parts: the physical standards for the plugs and wires, and the technical specifications for power and data transfer. Serial transfer was chosen over parallel because, while technically faster for the same clock speed, parallel data transfer is difficult to do over a long cable at speed. Problems with timing and interference are tough to crack. It also requires lots of data lines, which means big plugs and thick wires, all adding to the cost. From the start, USB was planned as being very cost-effective.

The original USB 1.0 of 1995 had

a Low Speed mode, running at 1.5Mbps, which equates to 187.5KB/s. USB 1.1 soon followed in 1998, and introduced a Full Speed mode of 12Mbps, or 1.5MB/s. This was the first widely implemented version, good enough for simple peripherals. In 2000, USB 2.0 introduced a High Speed mode, with a data rate reaching a more useful 480Mbps, or 60MB/s. It also introduced a battery charging mode. This starts to get more useful; file transfers and other more demanding tasks became viable.

2008's USB 3.0 (now also known as USB 3.1 Gen 1 – essentially the same thing) added a SuperSpeed transfer mode of 4Gbps. Actually, it's higher, at 5Gbps, but the addition of 8b/10b encoding costs 20% of the bandwidth (8 bits of data recovered for every 10 bits sent). It's often quoted as capable of 60MB/s, but in action it starts to top out at around 3.2Gbps, which is 400MB/s. Now USB is starting to become a viable means to shift large amounts of data and connect external drives.

PICKING UP SPEED

2013 brought us USB 3.1 and SuperSpeed+ mode (they'll run out of superlatives at this rate). This raises the bar to a theoretical 10Gbps, and a practical one of 7.2Gbps, which equates to 900MB/s. The encoding changed to 128b/132b, giving a negligible 3% overhead. These super modes required double the data lines – the cables have an extra two pairs of data wires. Here we are in the realms of mass storage devices, such as SATA 6Gbps.

One of the boons of USB is the backward compatibility; in theory,



Back in the dark pre-USB ages, every peripheral needed a different type of connector, such as this bulky five-pin plug for a keyboard.

you can plug pretty much anything into anything, and it works, not unlike PCIe. Obviously, to get SuperSpeed+, you need both device and controller to be USB 3.1, but you can still plug into lesser iterations of controller, and it does the best it can.

Adding power to USB was inspired. It cut out that ugly mass of transformers under your desk, and relieved the peripheral manufacturer of the cost of supplying one. The initial specification was for 500mA at 5V. USB 3.0 took this to 900mA for its increased data rates. And there's a charging mode, which can deliver 1,500mA. USB 3.1 has a Power Delivery mode that offers 5A at up to 20V, considerably expanding its potential as a charging format.

And now we come to a slightly annoying part. For such a universal standard, there's a fair number of different plugs and sockets. These fall into three groups: standard, mini, and micro. The standard type was



USB has become the standard for attaching your keyboard and mouse, and for clever surround-sound headsets, too.



USB Type A: The blue tells us it's the SuperSpeed version. It's designed so that it can plug into a USB 1.1 or 2.0 socket, and speeds drop accordingly.



USB Type B: Although less common than its counterparts, it supports everything from USB 1.0 to 3.0. It's often found in printers and more industrial peripherals.



USB-C, the best yet. It's small, doesn't mind which way you plug it in, and has enough data lines to cope with all current standards, even Thunderbolt 3 and over.

PICTURE BY ANIL ÖZTAS

designed for full-size desktops and peripherals. Type A is the familiar flat one used on memory sticks. Type B is square — for some reason, external drives and printers favour these. OK, it does stop you from plugging USB devices that must go into your PC in a peripheral that can't do anything with them, or getting too confused about what goes where. More practically, it means you need a different cable.

The mini-A and mini-B sizes are designed for mobile devices, although not used much these days. They have been "deprecated" to avoid a proliferation of standards. Micro-A and micro-B are intended for very thin gear, such as cell phones. As the plugs get smaller, they get more robust, as mobile devices are plugged in and out more often.

Then we have the SuperSpeed sockets and cables to accommodate the extra pins. There are SuperSpeed Type A, Type B, and micro-B. There is

some useful backward compatibility here, too — you can plug an original into a SuperSpeed version. On most of these plugs and sockets, the chances appear to be more than 50-50 that you try to plug it in upside down.

On that note, we have USB-C, something of a departure. This can be used in both orientations, at last. It also allows power transfer in both directions. USB-C is favoured by Apple, it's also appearing on increasing numbers of smartphones, and starting to appear on Windows laptops. It's not a USB standard as such, but a new expanded connector. It has a more substantial 24 pins — there is some redundancy here, depending on its use. The extra data lines add considerably to its potential longevity. It's small, neat, and a step up in design on previous versions.

A 'C' CHANGE

Apple really went for it on its 2015 MacBook, which had just one USB-C

port. This was not universally popular, as the first thing most users had to do was get an adapter so they could plug in a memory stick, or just about anything else, for that matter. Technically, USB-C, or Type-C (for some reason, C has a hyphen, but A and B don't), looks a good bet, although two years after its introduction, it's still the outsider. That will change, though.

USB-C is designed to replace all the current sockets, and alleviate the number of combinations that brings. The 10 standard socket types give us 21 possible cable combinations, not counting nonsensical configurations, and a further 12 deprecated and non-standard ones. Realistically, you'll probably only need four or five USB cables to use nearly everything — even so, it's easy to get caught without the right combination at hand. Sockets and plugs are often colour-coded. Standard ones are black; SuperSpeed are blue; yellow, orange, or red are for charging ports; and

STRUCTURE, MODES, AND CABLES

USB is simple and flexible. It scales nicely, capable of running very basic devices, such as a keyboard, right up to demanding mass storage devices. It is all based around a single controller on the host machine. All communications are initiated by the host — devices cannot communicate directly with each other. Each device is assigned an address. The host controller sends packets of data, one bit at a

time. Every connected device receives the data, but only the specified device responds, and only one device at a time can reply. Despite the huge number of devices you can connect at once, it essentially only talks to one at a time.

USB has four data transfer types, which help make it so flexible. Control transfer does the initial housekeeping and setup. Bulk transfer is for when it's vital you get every bit, such as

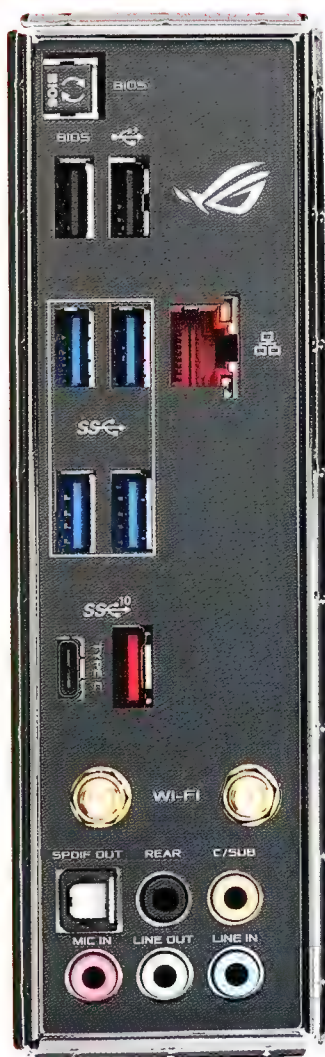
file transfers — here, bandwidth and latency may suffer. Interrupt transfers are for peripherals that require a quick response, such as a mouse — latency is prioritised here. It involves regularly spaced transfers set by the device, the host collecting one packet at a time. Isochronous transfer prioritises bandwidth, and there may be data loss. This is used for real-time video, such as webcams or audio, where keeping

going is more important than the odd dropped bit. When you plug in a device, it passes a USB class code to the host controller, and picks the appropriate data transfer mode and type.

The original USB 1.1 standard allowed for a 3 metre cable. The limit was down to the time allowed for a device's response to a host request, as well as maintenance of signal integrity. USB 2.0 raised this to 5 metres.

SuperSpeed modes are more demanding. There is no specified maximum, but 3m is recommended. You can work around these limits by using powered hubs; each acts as a signal repeater, maintaining integrity and timing. As you can run five tiers from a host controller, you can reach 15 metres, if you really need it.





Your motherboard defines how many USB ports you get to play with. More modern boards offer Type C connectors as well.

green ones are special Qualcomm Quick Charge ports.

The USB subsystem is built around a USB controller on a host machine, part of a motherboard's chipset these days. One USB controller can address a maximum of 127 devices — the controller itself counts as one device, so that takes us to the neat binary number of 128. Each USB device downstream is the end of the line, however; that's where the data lines end. Since there are no controllers in USB devices, no daisy-chains are possible. To attach more devices, you need a hub. This simply splits the wires out into more USB ports. If you connect devices that draw significant power, you need a powered hub, otherwise the 500mA gets shared out, too. USB supports up to five levels of branching. To the controller, your mass of devices appears as one long line with branches, each ending in a device.

USB is cheap to implement, especially in its simpler Low Speed mode. This, along with providing power, easy computer control, and its sheer proliferation, has made it an ideal platform for the strange world of the desktop toy, from kitsch novelty lights and fans through to the bizarre and frankly disturbing. Apart from the remote-control Nerf gun, of course, these are all great.

The number of USB ports you have on your rig is not necessarily the number of USB controllers you have. One controller can be wired to any number of ports through an internal hub. Intel's X99 chipset, for example, has up to 14 USB ports, according to the literature; up to six configured as USB 3.0, the rest as USB 2.0. However,

it only actually has three USB controllers: one USB 3.0 and two USB 2.0. More recent chipsets are more lavishly equipped, using internal High Speed I/O lines. The Z170 has up to 10 HSIO lines available for USB 3.0. Remember that port, hub, and controller (or root hub) are three different things.

THUNDERBOLT FROM THE BLUE

If there is an industry standard, Apple will probably do something else. After the company's experiences with FireWire (see box below) it looked around for another high-speed interface to combine USB, PCIe, DisplayPort, and FireWire functions. It liked the look of Intel's Light Peak, originally designed for an optical connection. Under Apple, it emerged as Thunderbolt.

Version 1 and 2 used a Mini DisplayPort connector, while Thunderbolt 3 moved to USB-C. Despite its origins, it's all copper. The optical route was found to be an expensive one — and, anyway, it couldn't carry power and the copper version proved faster than expected. Essentially, Thunderbolt is a combination of DisplayPort and four PCIe lanes mashed together (multiplexed) into two Thunderbolt lanes and unscrambled at the other end. One port can support six devices, either through a hub or daisy-chain, with the monitor at the end of the chain.

Thunderbolt 1.0 ran DisplayPort 1.1a and x4 PCIe 2.0 lanes, version 2 moved to DisplayPort 1.2. The big jump was Thunderbolt 3, which moved to PCIe 3.0, and threw in USB 3.1 and HDMI 2.0 support. Theoretical data

WHATEVER HAPPENED TO FIREWIRE?

USB's main rival in the early years was FireWire. In 1987, Apple, IBM and others started working together on a new high-speed interface. By 1995, it was ready, and it was technically something of a triumph. FireWire — or IEEE 1394, as it is more properly known — could manage 400Mbps in both directions simultaneously, supply up to 1.5A at 30V, and daisy-chain up to 63 hot-swappable devices. Apple added it

to its Macs. Sony used it on its first generation of semi-professional digital video cameras. Microsoft and Intel took an interest. It looked as though it was going to be a thing.

On the cusp of success, the wheels started to fall off. The collaborative effort had also produced 261 patents across 10 companies. Apple decided it wanted US\$1 per port royalty payment. A fuss was made, and eventually

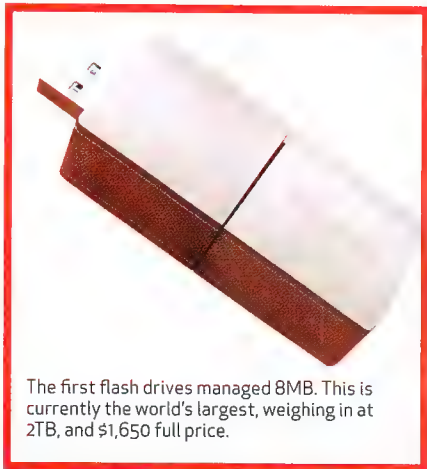
the cost was dropped to \$0.25, which was to be distributed to all parties. The damage was done, though. Intel pulled out in a huff and added USB support to its motherboard chipsets, rather than FireWire. USB had reached version 2.0 by this point, and the speed difference had eroded. Motherboard manufacturers could add USB at very little cost, while supporting FireWire meant adding an extra controller chip

and paying royalties. Most didn't bother. Peripherals went with USB, and that was that.

Faster versions — FireWire 400 and 800 — couldn't save it. In 2008, Apple started dropping it from new Macs; 2012 saw the last FireWire Apple product. There were other issues that didn't help: different non-compatible cables for each iteration, and confusing names (Sony called it iLink). It survives here and there, mostly in DV,

but as a mainstream PC technology, it is dead. Royalty payments can make you a fortune — just ask IBM. However, they are always resented. If the success of a product is in the hands of others, then asking for substantial royalty payments is also asking for trouble.





The first flash drives managed 8MB. This is currently the world's largest, weighing in at 2TB, and \$1,650 full price.



As USB-C and Thunderbolt take off, we'll see more of these; Apple does have a habit of removing ports before people are ready.



Wireless USB: It worked, now think of something to do with it that Wi-Fi can't do much faster and cheaper.

rates doubled each time, from 10Gb/s to 20Gb/s, and with version 3, a not inconsiderable 40Gb/s. Real-world speeds are down, of course; it has 128b/132b encoding, and various other overheads, but tests have version 3 in the range of 25Gb/s. So it's quick, which it needs to be if you're going to run a 4K screen and more.

Thunderbolt is not just for Macs; the full rights are back with Intel, and it has done the lion's share of the development, so anybody could, and will, use it. Windows laptops run it, and Intel recently announced that at some point next year, Thunderbolt will become royalty-free. Given that the specification includes USB 3.1, is it a rival? Yes and no. For the high end, it looks promising. For the mass market, it's far too expensive. A Thunderbolt hub capable of building your daisy-chain is the best part of \$300; a USB one is barely \$30. The on-board controllers are always going

to be expensive.

While USB 3.1's SuperSpeed+ is fairly nippy, it doesn't quite match a single PCIe 3.0 lane. The next iteration is USB 3.2, tentatively due for release before the end of the year. Data transfer rates are set to double to a theoretical 20Gbps, which translates into a practical maximum of 1,800MB/s. It's to be called SuperSpeed++ (they did run out of superlatives after all). It's been designed around the USB-C connector, and existing cables are said to be compatible. Looks as if it'll use double the data wires. Don't get too excited yet, though — certification and validation are expected to take us into 2019 before we can take the hardware home.

It looks like USB-C is being groomed to be the main peripheral connection format, with both Thunderbolt 3 and USB 3.2 using it. One cable, one socket for everything from your monitor down to the most pointless USB

desktop toy. Given the number of Type A devices knocking about, it'll be some time until we see the back of the familiar rectangular USB port, though you might have to buy an adapter or two at some point — but Mac people are used to that.

USB has brought a level of seamless connectivity that we now see as the norm. You just plug a device in and off it goes. It has been hugely successful. It's killed off numerous rivals, from the chunky old parallel port to more capable ones, such as FireWire. The sheer number of USB devices in the world ensure it'll be around for a long while, and any replacement will have to offer compatibility. Its future lies with USB-C and as a subset of Thunderbolt. USB's proliferation of cables and sockets will slowly resolve down to just one socket that'll be capable of nearly everything required for peripherals; truly universal. ■

WIRELESS USB: THE QUESTION NOBODY ASKED

In 2005, we were promised wireless USB. The idea seemed sound enough at the time. The USB Implementers Forum still has a page trumpeting the project. It points out that there are (or rather were — it is an old page) two billion wired USB devices. Wireless USB would bring the speed and security of a wired connection together with the ease of use of wireless. It would use Ultra Wide Band radio to establish a

short range connection between host and device. At around 3 metres it would offer USB 2.0 speeds. Performance dropped off with distance, down to a quarter of that at 10 metres or more.

Unfortunately, this proved a troublesome project. The regulations surrounding UWB are different all around the world, and there was considerable paperwork and negotiation to be done. It took until 2007 before anything was

ready to launch; Belkin got as far as selling the gear. It proved unimpressive, data rates weren't as good as expected, and the range was severely limited, down to six feet for decent transfer rates. It was, at least, easy to use. Sales did nothing, and it died.

There was a rather obvious problem with the concept: Wi-Fi. All the major peripherals had already gone wireless: cheaply, with a decent range, and much

faster. Ironically, USB proved the ideal port for the \$20 Wi-Fi adapters it used. There's another fly in the ointment: no power. Cut off from the cable, your wireless USB hub needs a power source, so you need yet another transformer plugged in at the wall. Actually, if it's not too far away from your system, the best bet would be a USB cable. Oh, no — hang on. Quite.

There was actually a



second stab at getting it going, around 2013. It was radically altered and called Media Agnostic USB this time. The concept used a range of Wi-Fi frequencies and standards. Unfortunately, the horse turned out to be dead after all.

how to

» QUICK TIPS

Experts solve your computing problems

APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

WINDOWS

UNINSTALL A STUBBORN WINDOWS 10 PROGRAM

I recently installed a program and now I find that my Windows 10 PC has slowed to a crawl. The app is obviously to blame, but how am I supposed to remove it when everything keeps hanging and crashing all the time? Can you help?

Eddie Oswald

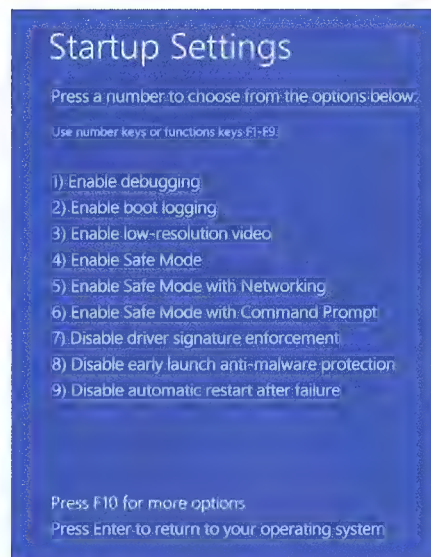
If you can get into Windows 10, click Start and hold Shift as you select Restart. When the 'Choose an option' screen appears, select Troubleshoot > Advanced Options > Startup Settings and click Restart. When the boot menu appears, press 5 to launch Windows in Safe mode, then remove the troublesome program via Start > Settings > System > 'Apps & features'. Once removed, restart your PC and it'll boot back into normal mode, with your problem hopefully rectified.

Mayank Sharma

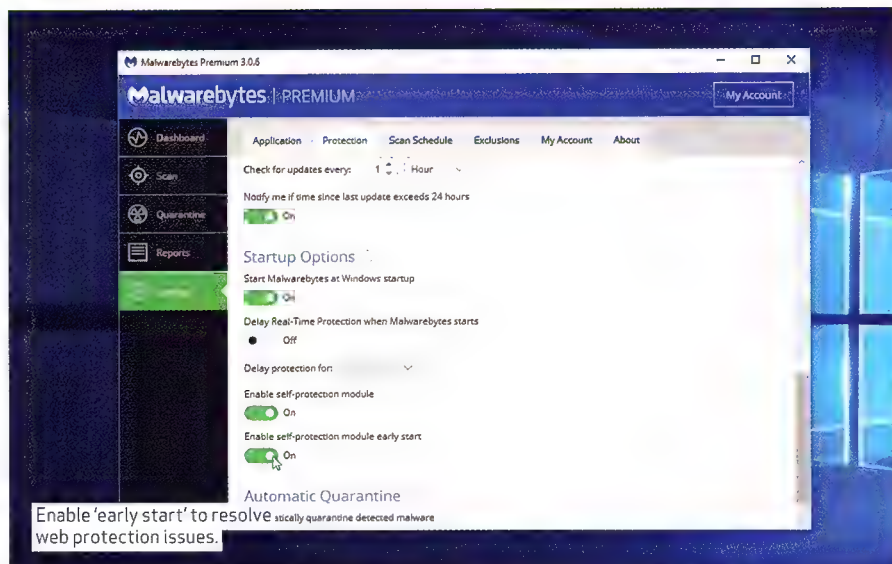
SECURITY

MALWAREBYTES REAL-TIME PROTECTION

I'm running Malwarebytes Anti-Malware Premium and I've started getting messages telling me that the real-time protection is switched off. If I try to switch it back on again, it doesn't seem to work — it appears



Remove troublesome apps using Safe Mode.



to be linked to the web protection module. Can you assist?

Albert Lechaude

Malwarebytes' web protection layer helps block websites marked as malicious from a range of programs, including Skype as well as your web browser. Version 3.0.6 was supposed to fix a range of real-time protection issues, but this problem persists for many. First, open Malwarebytes and go to Settings > Protection. Now scroll down to the Startup Options section and flick the switch marked 'Enable self-protection module early start' to On. Reboot your PC and see if the problem now fixes itself. You may still get a warning about the web protection module being switched off from time to time, but clicking the button to resolve it should now work.

Nick Peers

MAC

STAY CURRENT ON A BROADBAND BUDGET

What's the most efficient way to obtain software updates for my iMac and MacBook without exceeding my broadband cap?

Colin Heaton

The largest updates you're likely to need are to macOS itself. Rather than

downloading them from the Mac App Store, check Apple's support pages (support.apple.com) a day or so after release. Search for something like 'macOS 10.12.6', and get the smaller, incremental update (which updates only from the version immediately before its target), not the much larger Combo version. These are delivered as disk images, which you can copy to and reuse on additional Macs. Mac App Store apps can be copied from one Mac to another, but you may be asked for your Apple ID to reauthorise the second one. See apple.co/29b5KzD if you have trouble. OS X Server can cache updates for macOS, apps, personal iCloud data, and other store downloads when one Mac requests it, and distribute it to others as needed, but this imposes its own overhead.

Ian Sleightholm

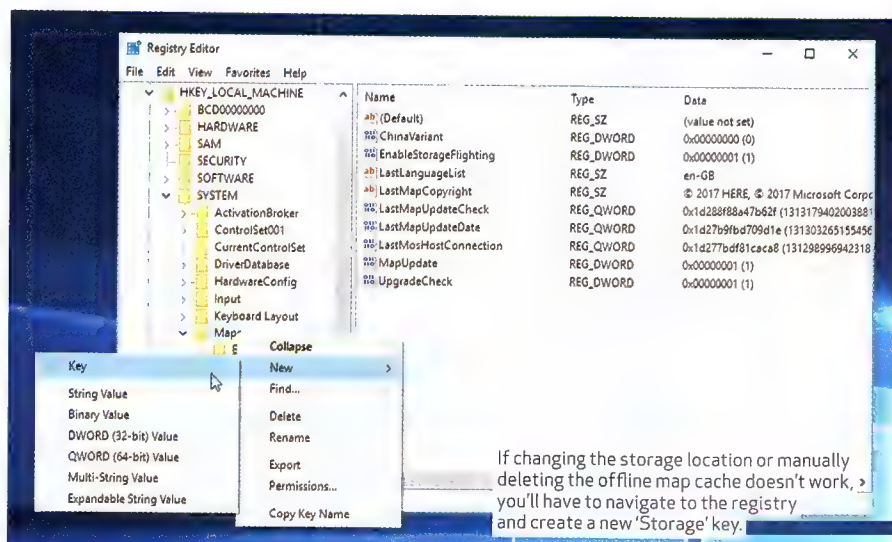
WINDOWS

THE MICROSOFT MAPS APP WON'T LAUNCH

My Microsoft Maps app has stopped working. I ran a troubleshooter that indicates the Maps' cache is corrupt. Please help!

Alan Orrell

The Offline Maps cache is the culprit here, and there are three main areas you can investigate in order to try and



resolve the problem: Settings, the cache folder and finally the Registry. Here's how to investigate further.

1 Click Start > Settings > System and then select 'Offline maps' from the left pane. If you're able to, try clicking the 'Delete all maps' option or changing the storage location to see if that is able to resolve the problem with Maps.

2 If that doesn't work (or the 'Offline maps' page loading gets stuck), browse to the following folder and delete all of its contents: C:\ProgramData\Microsoft\MapData\diskcache\BundleStore. Try Maps again. With a little luck it should work this time.

3 Still no joy? Press Windows-R, type `regedit` and Enter. Browse to `HKEY_LOCAL_MACHINE\SYSTEM\Map`. Look for a Storage key – if it

doesn't exist, right-click Maps and choose New > Key and name it 'Storage'.

4 If the key already exists, look for a `MapsPreferredDeviceGuid` value in the right pane. Right-click this, then choose Delete to remove it and reset the offline maps cache back to its default location on your C drive. The Maps app should now work correctly.

Nick Odantzis

SECURITY

LASTPASS RESET

I have got my knickers in a twist, having forgotten what password I originally used when setting up LastPass. I want to start over by clearing out the old password, but I keep going around in circles. Is there a set procedure I should follow?

Bryan Little

If you're trying to recover your master password, then your options are sadly limited since LastPass has no record of it stored for obvious security reasons. If you've previously managed to log on successfully with your master password, then open the browser you logged on through, go to lastpass.com/recover.php and follow the prompts. If successful, you'll activate a locally generated one-time password that will enable you to generate a new master password, or – if you've updated the master password within the last 90 days – revert back to the previous one. If this fails, you'll have to reset your account – this will free up your email address for use with LastPass, but all your existing saved data will be lost. Go to lastpass.com/delete_account.php?np=1 if you're happy to go down this route, as Bryan was.

Cat Ellis

EMAIL

TRANSFER YOUR OLD EMAILS TO THE CLOUD

How can I easily transfer emails from my old internet provider to Gmail?

Bernadette Wallis

You could simply forward them on to your Gmail address, but the following technique is quicker, and should work with other cloud providers such as Hotmail too. We've used Thunderbird here (getthunderbird.com), but you should be able to adapt it to your own particular email client.

1 Log into your Gmail account at mail.google.com using your web browser. Click Settings and select the 'Forwarding and POP/IMAP' tab. Scroll down, select Enable IMAP and then click Save Changes to access Gmail through your email client.

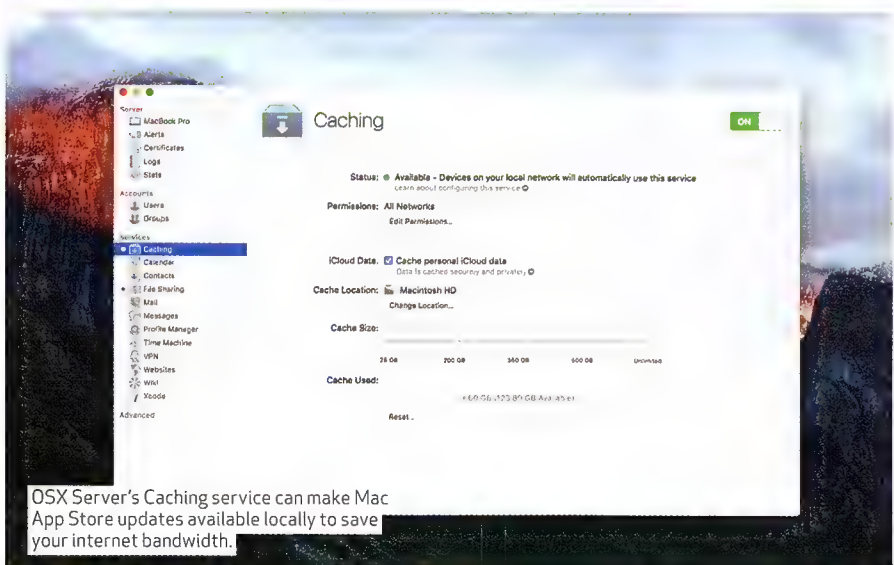
2 Open your email client and add Gmail as an additional account – in Thunderbird, select Local Folders and click Email under 'Create a new account'. Skip the new address prompt, type your Gmail address and password and click Continue.

3 Leave IMAP selected, then click Done. You'll need to sign in to Google and authorise the connection to complete the process. Thunderbird will now begin to download all your mail (including any folders) – you don't have to wait for it to finish.

4 Now you can now simply transfer your messages by dragging them from your old email account into the desired folder on Gmail (you could set up a dedicated folder for this purpose). They should automatically sync online when you're next connected.

Rob Mead-Green

"Rather than downloading them from the Mac App Store, check Apple's support pages a day or so after release."



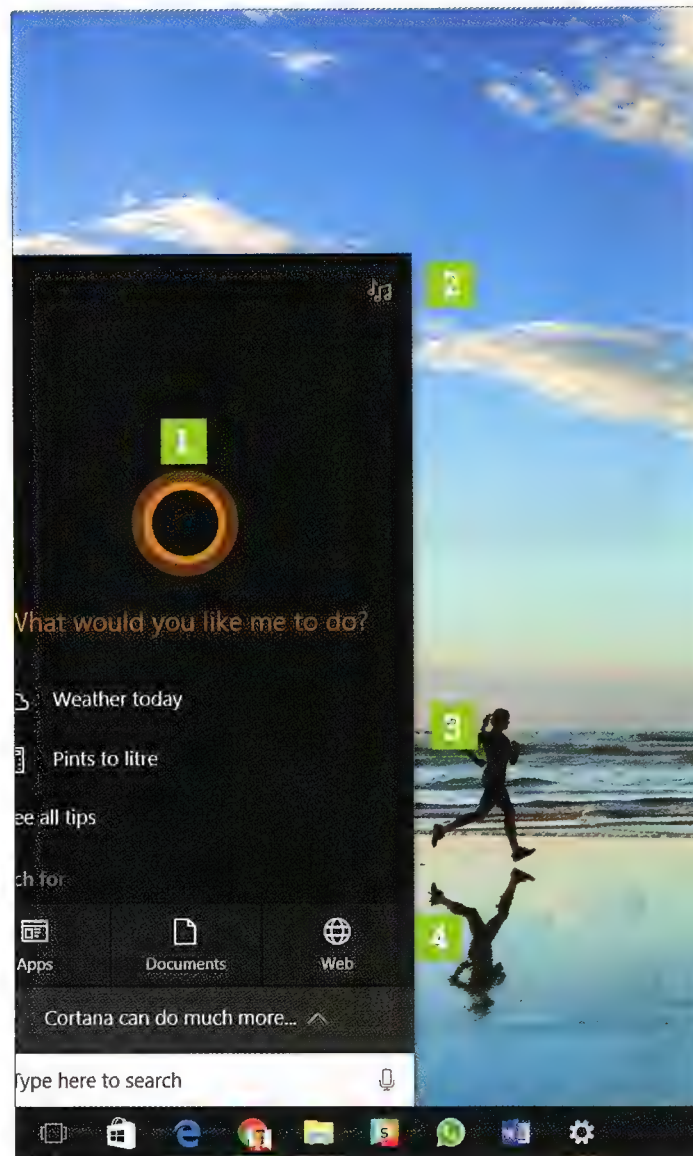
OSX Server's Caching service can make Mac App Store updates available locally to save your internet bandwidth.

Do more with Cortana in Windows 10

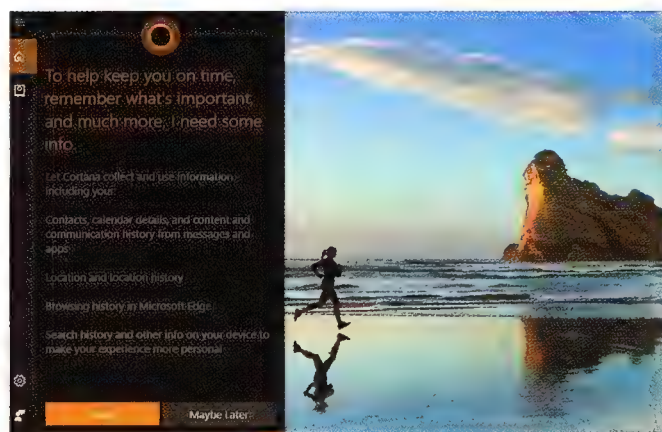
It's even easier to get help from Cortana, thanks to the latest Windows 10 Creators Update and Dan Grabham.

Windows 10 is constantly evolving. The Creators Update has now rolled out to most PCs and we've got another Fall update arriving later in the year, in our spring. As part of this, Cortana is also changing as new features are added and others improved. One thing is for sure – Cortana is here to stay. She even has a promoted role as you set up new devices; Cortana now helps you with the setup.

You will need to be running the latest version of Windows 10 to use many of these features and some others are rolling out as 2017 goes on (not all languages are being rolled out together, as we'll explain). To make sure you have the Creators Update installed, go to 'Settings > System > About'. Your Windows 10 version number needs to be 1703 or later. Haven't got it? Then go to bit.ly/2vaWuuR to download it. So let's take a look at what's new...

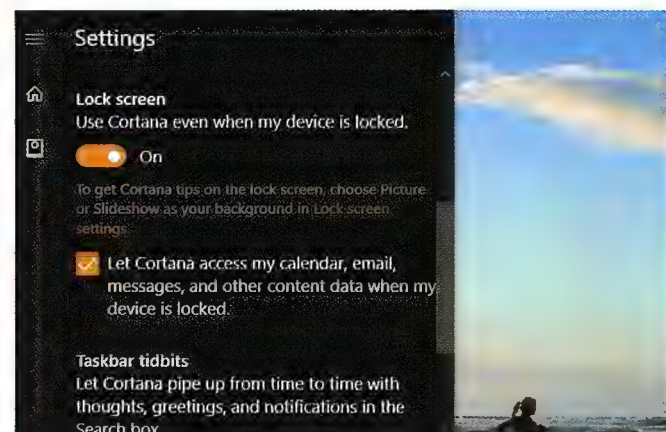


Check out Cortana's new features



1 GIVE CORTANA ACCESS

Cortana relies on access to your personal information. Without this, it's just another way to search for your files and the web, and can't offer you personalised results. You need to give her permission to access your location, browsing history (Microsoft Edge only) and search history. You can tweak the information that Cortana collects in Settings (the gear icon in the left menu bar).



2 LOCK SCREEN ACCESS

Cortana can now be accessed from the lock screen so you can say 'Hey, Cortana' and let the assistant invoke automatically without even touching your PC. You can turn this on in Cortana's Settings, and opt to let her have access to your calendar and email, too. Remember: because your PC is locked, this could give someone unauthorised access to basic personal info.



1 NOW HEAR THIS
Cortana is listening. Say 'Hey, Cortana' to let it know what you'd like it to do. You can also use the search box, too.

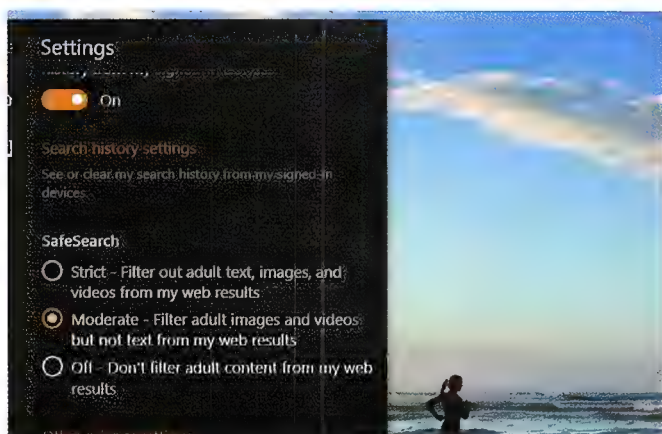
2 MORE MUSIC
Cortana now works with other music apps such as TuneIn Radio. See the music icon in the top-right of the menu.

3 CORTANA TIPS
You can click on one of these tips to get started with some well-known queries around weather and basic conversions.

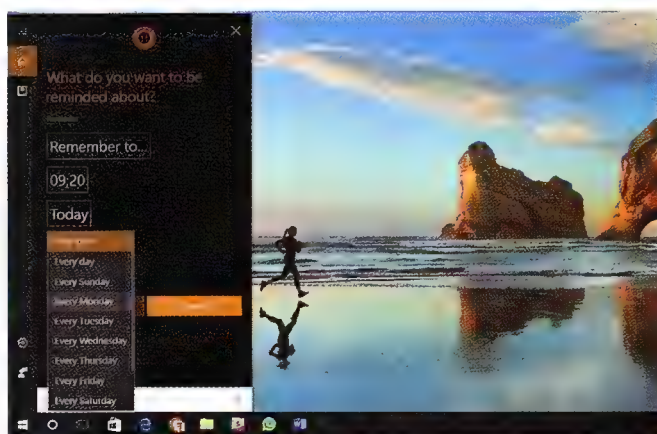
4 SEARCH BUTTONS
Click one of the Search buttons here to tell Cortana that you want to search Apps, Documents or the Web.

5 NOTIFICATION CHANGES
Cortana groups notifications, plus the notification text is now shown in a larger font, too.

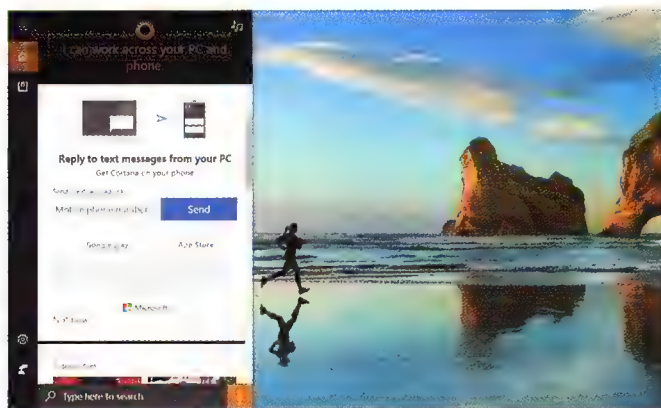
6 OTHER TIPS
In case you haven't noticed already, Windows 10 pops Cortana tips into the Action Centre — check them out!



3 IMPROVED SEARCHES
One area that Cortana wasn't that good at initially was searching, especially for her own settings. This has improved in the latest update. Web searches in Cortana have also got better, and Cortana now has SafeSearch settings so that there's no chance of anybody accessing web content that they shouldn't — there's a Strict setting in addition to a Moderate option.

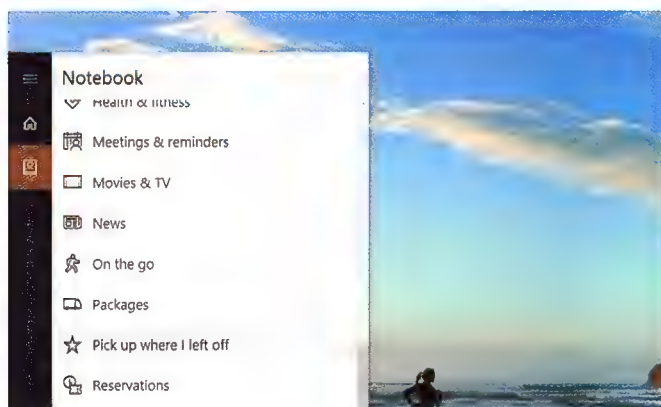


4 REMINDER IMPROVEMENTS
Also improved in Cortana is the assistant's ability to set reminders. You can now choose to repeat reminders, for example, on a particular day every week, or maybe every day. We think there should be some checkbox options here, too, so you can easily select required days (like Tuesday or Thursday). However, the initial setup of reminders works really well.



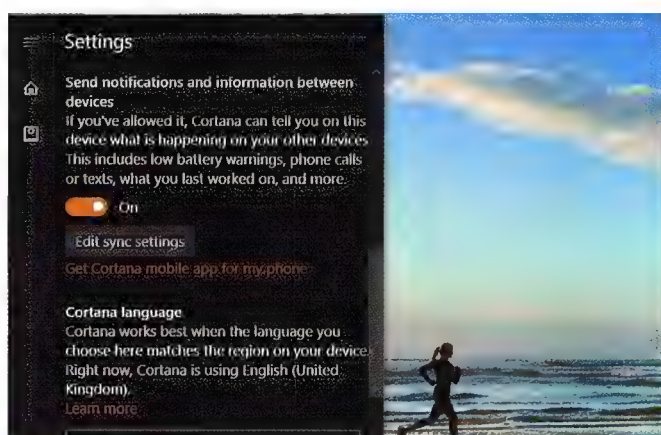
5 REPLY TO TEXTS ON YOUR PHONE

One of Cortana's most exciting 2017 features is the ability to reply to text messages from your PC. Third-party apps, such as Pushbullet, have enabled this for a while, but it's great to have the ability to do it natively on iOS and Android. All you need to do is to enter your phone number, download the Cortana app (or access it via your preferred app store) and follow the instructions.



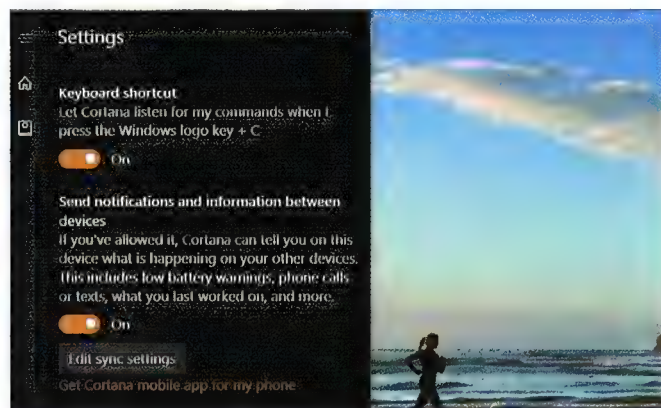
7 PICK UP WHERE I LEFT OFF

Another exciting feature, 'Pick up where I left off' enables you to do just that, but on another Windows device. To get it working, go to the Cortana Notebook (the second icon down in the left sidebar) and scroll down until you see the option shown here. Don't see it? Change Cortana's language to US English in Settings (this won't change your main Windows language).



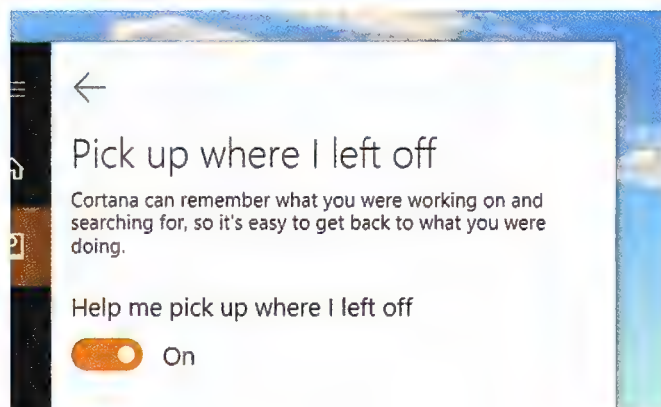
9 ENABLE NOTIFICATIONS

You need to enable something else in Cortana's Settings to make this work: the ability to send notifications and information between devices. That's because 'Pick up where I left off' sends a notification to other Windows 10 PCs you're signed into. This shows things like tabs in Edge that you're looking at on another PC. Clicking the notification lets you to pick up... you get the idea.



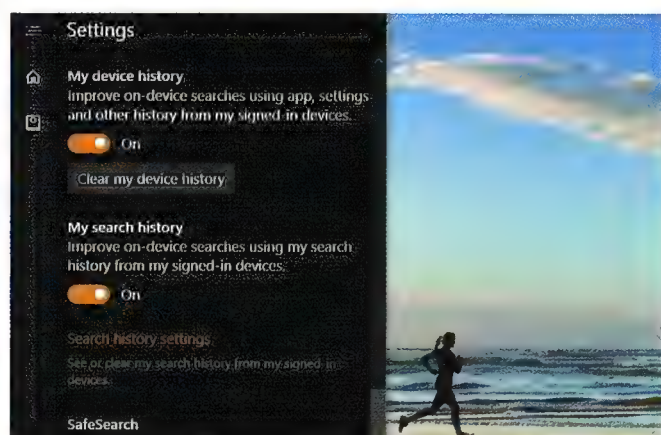
6 SHORTCUT TO CORTANA

You can also now invoke Cortana via a keyboard shortcut, Windows-C. A setting toggles this on and off in case you don't want to activate her accidentally. Many users won't find this so useful, but if you're a sucker for keyboard shortcuts, we reckon you'll love this one as you can get Cortana working for you without having to touch the mouse.



8 TURN IT ON

You'll then need to enable this setting. At the time of writing, 'Pick up where I left off' was only available for Windows 10 PCs where the Cortana language — or main display language in 'Windows Settings > Time & Language' — is set to US English. However, by the time you read this, it may well be available in AU or UK English, so check it out and see how you get on!



10 DEVICES AND SEARCHES

You can also improve Cortana's search results using the 'My device history' and 'My search history' settings. These improve searches because they coordinate apps you've set up and things you've searched for on all your devices. Cortana works best when you give her full access to your stuff, but these settings stop items on specific devices from being used by Cortana if you wish. ■

Encrypt your Linux setup

Nate Drake explores how to use the tools already built into your Linux installation to encrypt your files and shield your devices.

Any grizzled yet privacy-conscious Ubuntu users may remember that, back in the day, keeping your data safe was far from easy. The steps involved either supreme mastery of the command line or using an alternate installation CD to encrypt your Ubuntu installation.

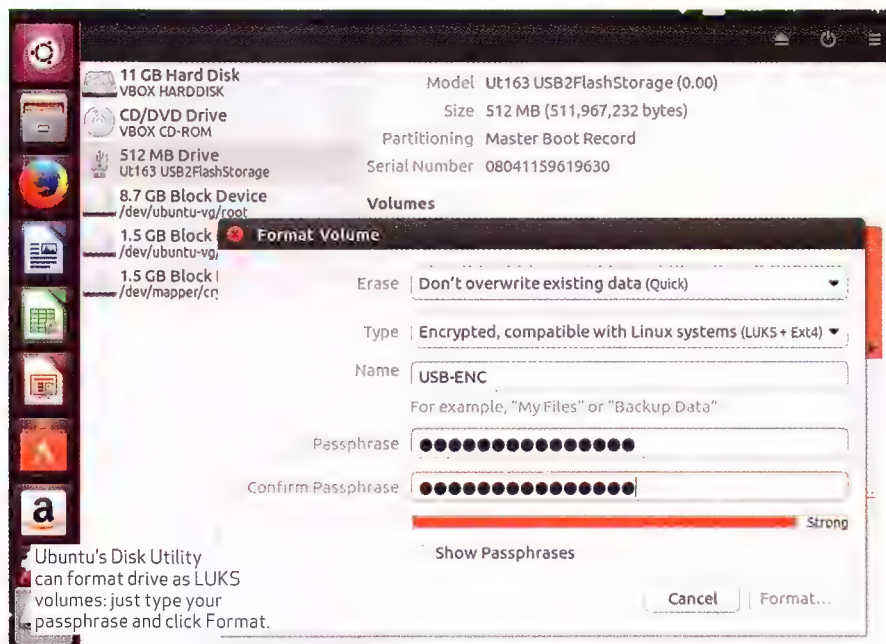
Things have changed. When you insert a DVD of Ubuntu and its variants, the graphical installer now offers you the option to encrypt your system using LVM (Logical Volume Manager), which manages disk drives on LUKS (Linux Unified Key Setup), the standard for Linux Hard Drive encryption.

For most users, this is a great way to save time, protect your system and avoid having to learn various confusing acronyms. Once the system installation is complete, your drive with the exception of the /boot partition is encrypted and can only be unlocked with a passphrase. Once you log in, most of the built-in disk managers even enable you to encrypt external drive using LUKS, so that a password is required each time you insert it. The same programs will often offer you the option to change the passwords for drives that are already encrypted.

On the face of it, it would seem that LUKS is purring away merrily under your computer's proverbial hood and there's nothing further to be done. This guide is designed for more curious readers. We'll explore the built-in encryption programs in Linux and you can modify them to suit your requirements, such as choosing your own encryption cipher or adding multiple passwords to a volume.

This tutorial focuses on Cryptsetup, a command line application which comes pre-installed in most Linux distributions. It functions as an interface for the 'dm-crypt' module, to enable you to quickly and easily encrypt drives. At its simplest level, you can use Cryptsetup to create plain volumes that are protected by a password only (see boxout, opposite) but you need to specify all the encryption options each time you access the device and, annoyingly, there's no easy way to change the password.

Luckily, Cryptsetup contains useful tools for creating and modifying LUKS encrypted volumes. Aside from



defining a universal standard for hard drive encryption, LUKS volumes contain headers that detail the cipher and hash used, as well as a unique 256-bit salt, which is added to your password for further security. The header also contains an encrypted master key that's used to unlock the container. This means you can change the password used to access the master key or add further passwords.

To get started with your voyage of discovery with LUKS, we strongly recommend you set up a virtual machine, or at the very least back up your data before proceeding. Once this is done, open your disk management program to view any LUKS-encrypted device, such as the system hard drive. You'll see the encrypted LUKS volume appears as a separate device, for example /dev/sda5. You can delve further into this using the 'LuksDump' command in Terminal: `sudo cryptsetup luksDump /dev/sda5`

KEEPING YOUR HEADERS

After running the 'LuksDump' command to bare open your LUKS volume header, the first thing you can see are the default encryption options used when you instruct Ubuntu to encrypt a drive for you using the installer or the disk utility. In the case of system encryption, Ubuntu uses 256-bit AES with the XTS Block

Cipher mode.

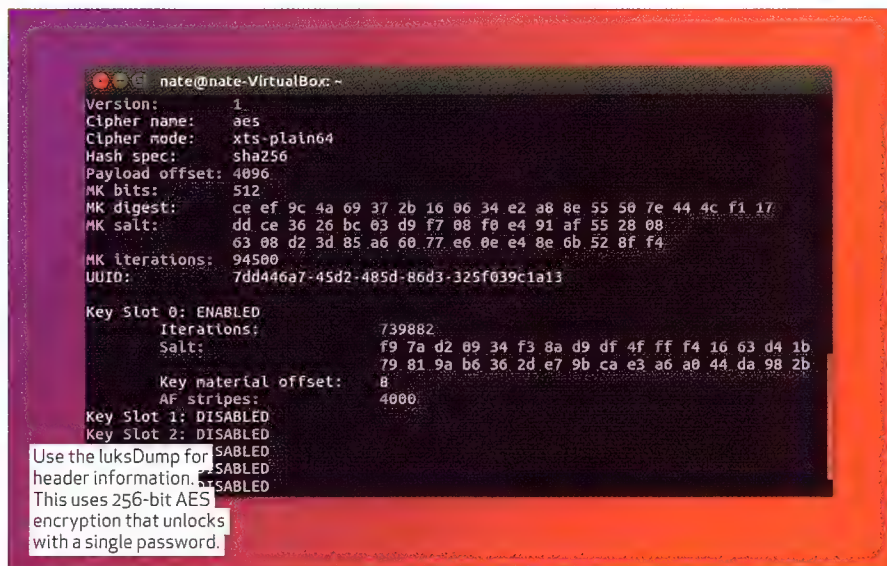
The MK (Master Key) salt is also listed, which hugely increases the security of your LUKS volume. Without it, there's no way to retrieve your data, even with the correct password. For this reason, Cryptsetup enables you to make backups of your LUKS volume headers and restore them, because if the header is damaged, there's no way to retrieve your encrypted data.

To make a backup of your LUKS header, open Terminal and run the command: `cryptsetup luksHeaderBackup <device> --header-backup-file <file>`

```
sudo cryptsetup
luksHeaderBackup /dev/sdb1
--header-backup-file /home/
nate/Desktop/backup1
```

To restore the header, simply run the same command but substitute 'luksHeaderBackup' with 'luksHeaderRestore'.

Once you've safely backed up your header, run the 'LuksDump' command above again and scroll down to the Key Slots section. By default, there are eight key slots, numbered 0 to 7. The first keyslot (0) is enabled with the password you chose when you originally encrypted the volume. If you want to give someone else access to your LUKS volume, you can add



another password or key file using
Crypsetup's 'luksAddKey' command,
for example: `sudo cryptsetup
luksAddKey /dev/sda5`

You'll need to enter an existing password. Cryptsetup will then ask you to enter the new password twice.

To remove a password from a LUKS volume, use the 'luksRemoveKey' option, `sudo cryptsetup luksRemoveKey /dev/sda5`. Cryptsetup will ask you to enter the password you wish to remove. Be careful with this feature because, if you delete all the key slots for a LUKS

container, you won't be able to access it again.

Kali Linux actually puts this feature to very good use through a nuke patch for Cryptsetup, whereby if a certain password is entered, all the key slots in the system's LUKS header are erased (More on this at www.kali.org/tutorials/nuke-kali-linux-luks). This is done to protect your device's data from theft or seizure but remember to back your volume header if you make use of it, or else you won't be able to access your machine either!

PUSHING YOUR LUCK

While Cryptsetup has some excellent default options to get started, you may prefer to have more control over your data. In the first instance, if you don't wish to encrypt an entire volume or drive you can create a LUKS file container, which can only be unlocked with a password. See the walkthrough over the page for a step-by-step guide on how to do this.

If you use the `luksFormat` option on its own when creating your container, then `Cryptsetup` will use the default encryption options. However, if you prefer you can specify these yourself.

```
sudo cryptsetup -y --cipher
serpent-cbc-plain --key-size
256 --hash sha512 luksFormat
test1
```

In the above example, the master key for container `test1` will be encrypted with the Serpent cipher algorithm, which was a finalist in the AES (Advanced Encryption Standard) contest. The SHA512 hash is used in place of the default SHA256, too.

Cryptsetup also supports using key files instead of passwords. These are particularly helpful when using plain mode, because files will most probably have a higher degree of entropy than passwords. For LUKS containers, you can add a key file by simply specifying the file location after `luksAddKey` `-` for example:

Good LUKS or plain?

LUKS containers don't make any attempt to conceal their nature, so if you encrypt a drive this way, it's obvious you've something to hide. Fortunately you can use Cryptsetup in 'plain mode', which contains no giveaway volume headers. To anyone examining the drive, it'll simply appear to be full of random data.

To get started, locate your chosen partition or insert a USB stick, open Terminal and wipe the drive with `dd`. For example, `sudo dd if=/dev/urandom of=/dev/sdb1 bs=1M`.

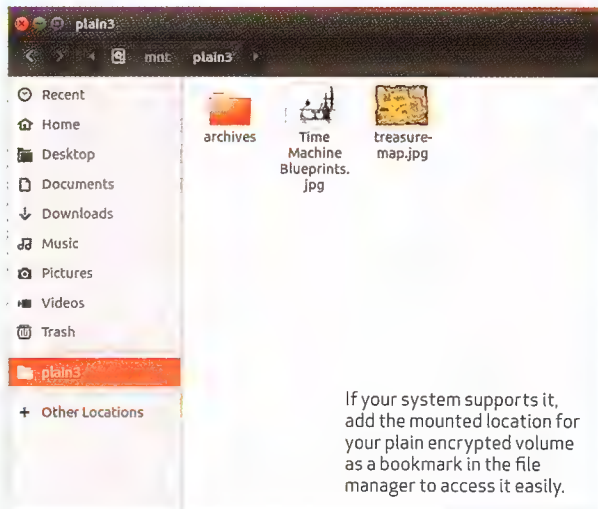
The basic command for using Cryptsetup in plain mode is `cryptsetup <options> open --type plain <device> <name>`. Take some time to read through the Cryptsetup main page to see which options are right for you, for instance:

```
sudo cryptsetup --type plain
--cipher=serpent-xts-plain64 --hash=sha512
--key-size=256
--offset=123 open /dev/sdb1 plain3.
```

This command must be entered in exactly the same way each time you want to access the device. If you're uncomfortable writing it all down, memorise the offset value.

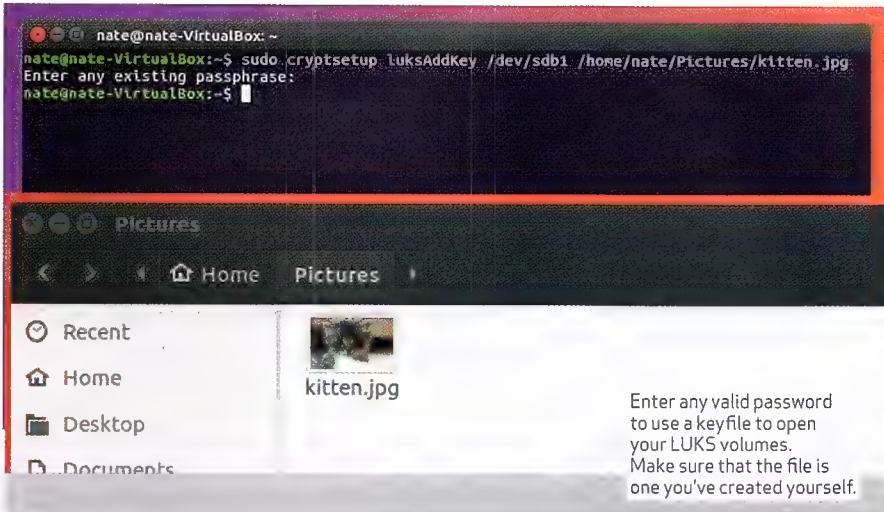
Cryptsetup will ask you to choose a password. Make sure it has a high degree of entropy as no salt is used (see above). Create a file system with `sudo mkfs -t ext4 /dev/mapper/plain3`.

Next, create a mount point by running `sudo mkdir /`



```
mnt/plain3, then mount the device with sudo mount -t ext4 /dev/mapper/plain3 /mnt/plain3. You can now write your secret files to /mnt/plain3. When you're done, run sudo umount /dev/mapper/plain3, then sudo cryptsetup close plain3.
```

You can access the encrypted drive again by running the `cryptsetup` and `mount` options.



```
sudo cryptsetup luksAddKey /
dev/sdb1 /home/nate/Pictures/
kitten.jpg
```

Enter any existing password to add the file to the key slot. To open a LUKS container using a key file simply specify the path using the `--key-file` option, for instance:

```
sudo cryptsetup luksOpen /
dev/sdb1 vol1 --key-file /
home/nate/Pictures/kitten.jpg
```

FRESH OUT OF LUKS

In the above example, an existing binary file was used of a kitten taken from Wikimedia. In reality, this would offer very poor security because anyone with a copy of the file could

open your LUKS Container. Either create an arbitrary keyfile from random data using or use a file to which only you have access, such as a photo you took yourself.

If you used `sudo` to create a mount point or format drives, you may find you cannot modify files in your encrypted containers at first as they are assigned to the root user. Run `sudo chmod -R 777 /mnt/<your mount point>` in Terminal to fix this.

Unlike third-party programs such as Veracrypt, Cryptsetup can't encrypt volumes using cipher cascades like AES-Twofish-Serpent. Using any one of these algorithms on their own will offer adequate security, but for the ultra-paranoid, you can create LUKS containers inside one another if you

wish. Simply repeat the steps in the tutorial using different encryption options for each container.

Remember that the strength of your container will rest largely on the amount of entropy your password has. If you have a good memory, try using DiceWare to generate a passphrase (world.std.com/~reinhold/diceware.html). We recommend the alternative Beale word list because it uses UK spelling and avoids Americanisms.

If you like the convenience of using LUKS for changing passwords but still aren't happy with everyone knowing you're encrypting data, you can create a LUKS container with a detached header. The advantage of doing it this way is that, by itself, the container just looks like random data, giving you some degree of plausible deniability. To do this, use the `--header` option when creating a LUKS volume to specify where to save the header. For example:

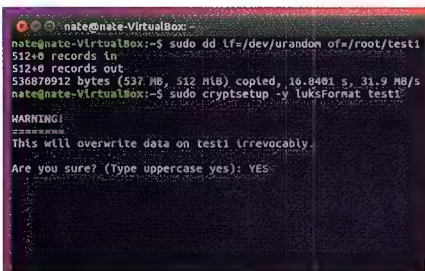
```
sudo cryptsetup luksFormat /
dev/sda --header /dev/sdb
--align-payload=0
```

When mounting LUKS volumes, specify the header location in the same way, for example:

```
sudo cryptsetup luksOpen /
dev/sda --header /dev/sdb Luks
```

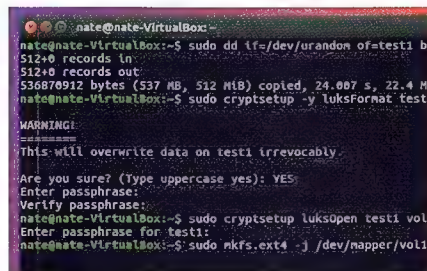
When doing this make sure you encrypt an entire drive or partition, because there's no plausible reason for you to have large files of seemingly random data on your system!

Create your LUKS-encrypted file containers



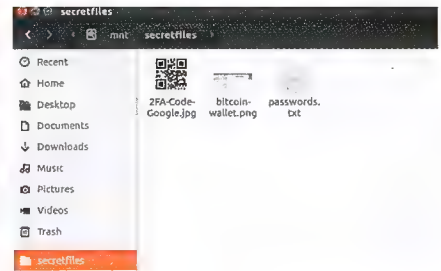
1 CREATE LUKS CONTAINER

Open Terminal and create a file of random data with `sudo dd if=/dev/urandom of=test1 bs=1M count=512`. This command creates a 512MB container. Modify 'bs' and 'count' to suit your needs. Change the name from 'test1' to something more meaningful if you wish, too. Next, add a LUKS header to the container with `sudo cryptsetup -y luksFormat test1`. Type "YES" and enter your password twice.



2 MOUNT YOUR DEVICE

Open your new container with `sudo cryptsetup luksOpen test1 vol1`. This opens your file as a local loopback device at `/dev/mapper/vol1`. Assign a file system to your device with `sudo mkfs.ext4 -j /dev/mapper/vol1`. Next, create a mount point, such as `sudo mkdir /mnt/secretfiles` and mount the device with `sudo mount /dev/mapper/vol1 /mnt/secretfiles`. Open your File Manager and go to your mount

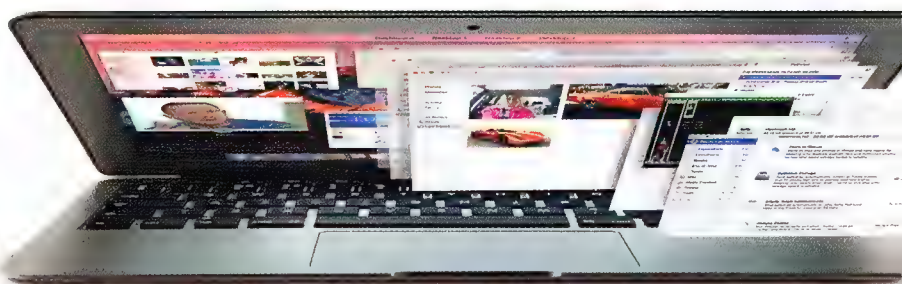


3 COPY YOUR FILES

Copy your secret files to the LUKS container. At this stage, you may want to backup the LUKS volume header (see above). To close the container, run `sudo umount /mnt/secretfiles`, then `sudo cryptsetup luksClose vol1`. Amend the mount point and volume names as necessary. To reopen run `sudo cryptsetup luksOpen test1 vol1`, then `sudo mount /dev/mapper/vol1 /mnt/secretfiles`.

12 hidden features of macOS

Explore some of the less well-known and quirky features on your Mac.



One of the many delights of being a Mac owner is that there is always another layer of intrigue hidden behind all the headline features, no matter how thoroughly you explore your system.

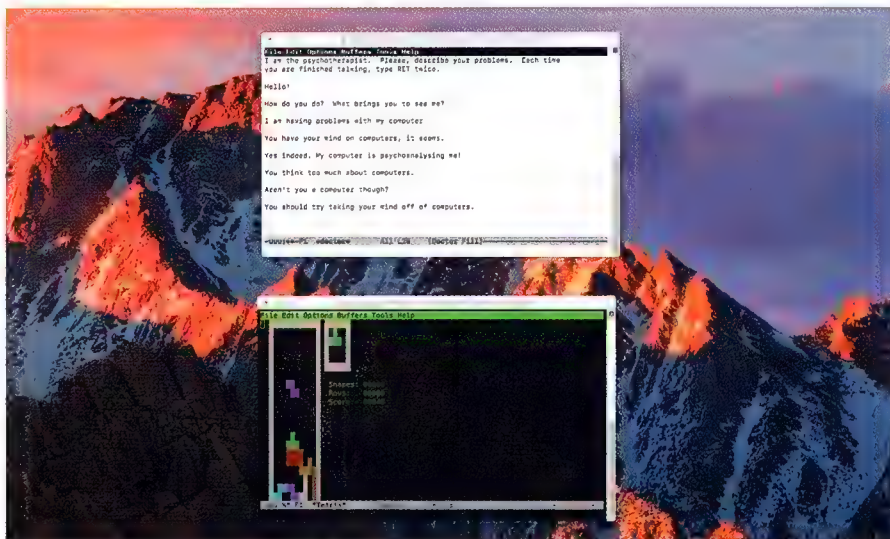
In this article, we will be looking at some of the secret treasures of the Mac, from hidden games (including your own digital psychiatrist) to more useful features, such as the ability to navigate your system more quickly and sign documents.

We will also explore how to activate and download offline text dictation and dictionaries in various languages, as well as Sierra's famed Picture in Picture mode, which is the bane of employers everywhere, as it allows you to watch streaming videos in a discrete corner of your desktop while you work.

None of these features are particularly harmful, nor do they require huge amounts of space. We nevertheless always encourage you to do a full backup of your system before making any major changes.

Many of these features also assume that you're running macOS Sierra or newer on your Mac. If you're uncertain, go to Apple > App Store, and click on Updates to confirm that everything's in order.

If you plan to use the Universal Clipboard feature, you will also need an iOS device, such as an iPhone, running iOS 10 or later.



1 MAC PSYCHIATRIST

Your Mac contains a number of hidden gems, including several retro games. One of these is a version of Eliza – a program created in the 1960s at MIT with which you can have a simulated therapy session.

To get started, click Spotlight on your Mac, enter **Terminal**, and press Return. When Terminal opens, enter `ls /usr/share/emacs/22.1/lisp/play` to show a list of installed games.

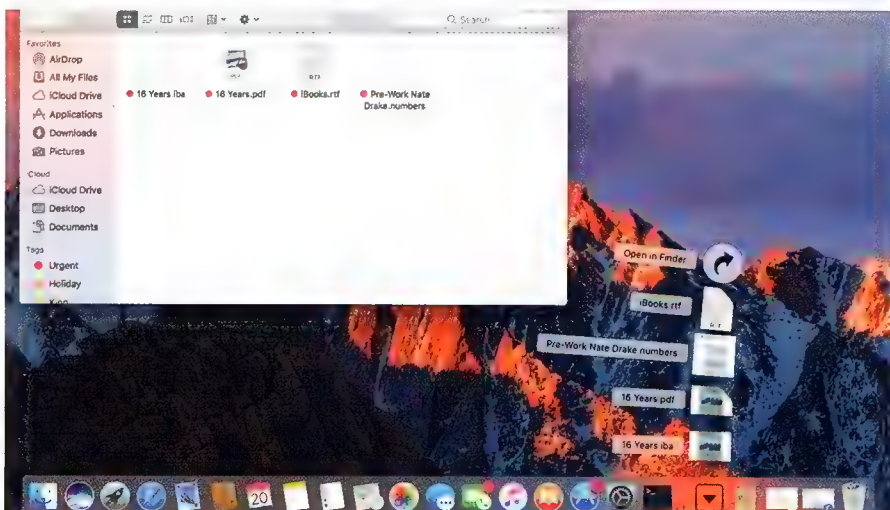
To launch a particular game,

for example, your Mac psychiatrist, enter: `emacs -q --no-splash -f doctor`

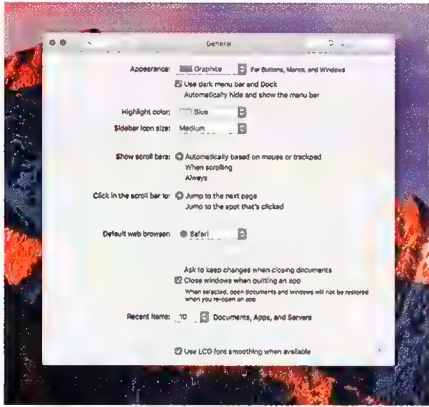
If you have no use for therapy, replace 'doctor' with 'tetrис' or any of the other listed games.

2 USE TAGS AND STACKS

You can organise your Mac files using colour coding with tags. To categorise files, for example, 'Urgent', Control-click and choose a coloured tag, available in the Finder sidebar.



"Your Mac contains a number of hidden gems, including several retro games."



Click on a particular colour to display all files with that tag.

Stacks are found on the right-hand side of your dock, and are a convenient way of viewing multiple files. By default, your Mac has a stack for files you've downloaded, for instance. You can also create a stack for a particular tag; simply drag it from the sidebar in Finder to the right-hand side of your dock. Click this to view files with that tag.

3 USING TEXT SHORTCUTS

Your Mac can save you time when it comes to words you use repeatedly. This is governed in the Text section of your Keyboard setting in System Preferences.

You can use this to transform an abbreviation into a longer phrase – 'appt' could become 'Appointment at:'. The text box supports paragraphs, so you can also use this to store longer email signatures.

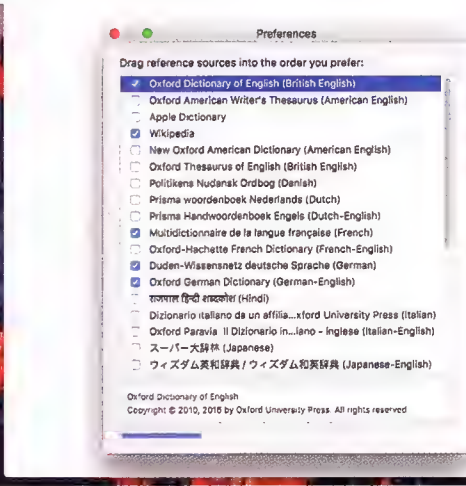
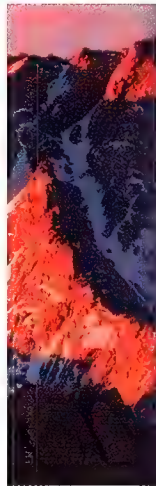
To use these shortcuts, enter the shortcut in a word processing application, such as Pages, and wait a moment and the replacement text will appear in a blue suggestion box, floating next to it.

4 SWITCH TO DARK MODE

The macOS Sierra includes a new feature called Night Shift, which gradually shifts your display colours away from the blue end of the spectrum after sunset.

Alternatively, in order to reduce your risk of eye strain, you can choose to use dark mode.

Click Apple > System Preferences > General. Tick the option marked 'Use dark menu bar and dock'. If you wish, you can also click the Appearance menu to change buttons, windows and menus from blue to graphite.



"Your Mac can save you time when it comes to words you use repeatedly."

5 DOWNLOAD DICTIONARIES

If you use a word processing application on your Mac, it most likely has a built-in spell checker, but if you're a true logophile then you may prefer to use macOS's Dictionary app.

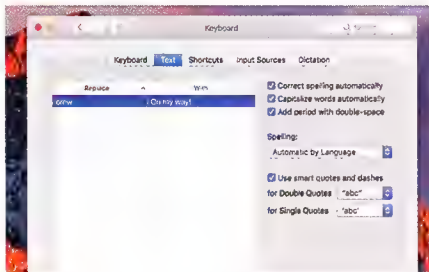
This is particularly handy if you want to look up the meanings of words in another language. Dictionaries are downloaded directly to the Mac, so you can use them offline, unlike online translation services. The app also looks up terms in Wikipedia if you are online.

To get started, click on Spotlight and type dictionary. Press Return to

launch the app itself. If this is your first time using the app, it may ask you to download some dictionaries before use – in English-speaking countries these will be the Oxford American Dictionary and the British Oxford Dictionary of English. Click Download to continue. Bilingual dictionaries will list both languages, for example, German – English.

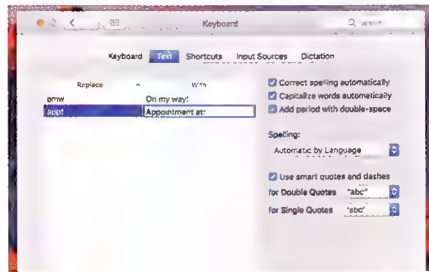
Next, click on Dictionary > Preferences. Here, you can drag your dictionaries into order of preference.

Create your own text shortcut suggestions



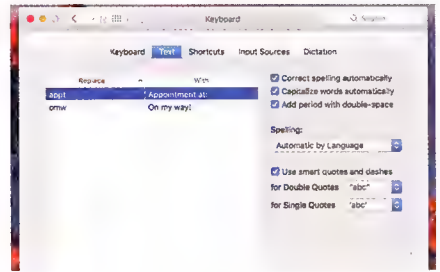
1 OPEN SYSTEM PREFERENCES

Click on Apple > System Preferences. Next, click on Keyboard. Look at the tabs along the top of the window, and click the one marked Text.



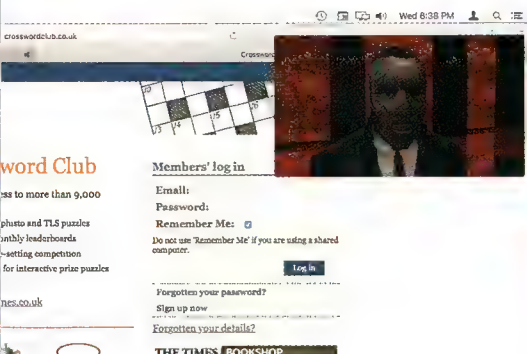
2 ENTER YOUR SHORTCUT

Click on the + button in the bottom left. You will now be able to enter text in the Replace field. Put your abbreviated text here, for example, 'appt'.



3 ENTER REPLACEMENT TEXT

Click on the Replace field to the side of the text you just entered. Here, you should enter the replacement text, for example, 'Appointment at:'. Press return to save.



British users may prefer to place the British Oxford dictionary at the top.

Select the tick box next to the name of any supported dictionary, like the Oxford German Dictionary, to download it. Once the download is complete, you can click your chosen language at the top of the dictionary window to look up a term.

6 PICTURE IN PICTURE

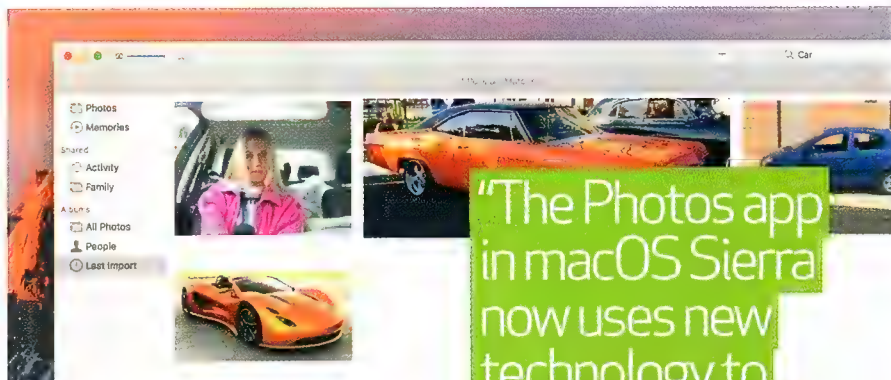
Picture in Picture is useful for watching sporting events and other media as you use your Mac.

The feature (which requires macOS Sierra 10.12.6) lets you display streaming video from compatible websites in a small window, which will stay on top of other apps as you work.

Open Safari, and begin playing a video on a compatible site such as Vimeo or YouTube. Control-click on the video, and choose 'Enter Picture in Picture' to start play. To stop the video, close the Safari window or tab.

7 UNIVERSAL CLIPBOARD

If you have a compatible Mac and iPhone (see bit.ly/sys_req_continuity), you can use the Universal Clipboard. This lets you copy text, images and videos on one device and paste them to another, so long as they are near



"The Photos app in macOS Sierra now uses new technology to identify objects and scenes."

each other. To use this feature, your iOS device and Mac must be signed in using the same Apple ID. You must also make sure both Bluetooth and Wi-Fi are enabled. Universal Clipboard requires iOS 10. Go to Settings > General > Software Update to check your iOS version.

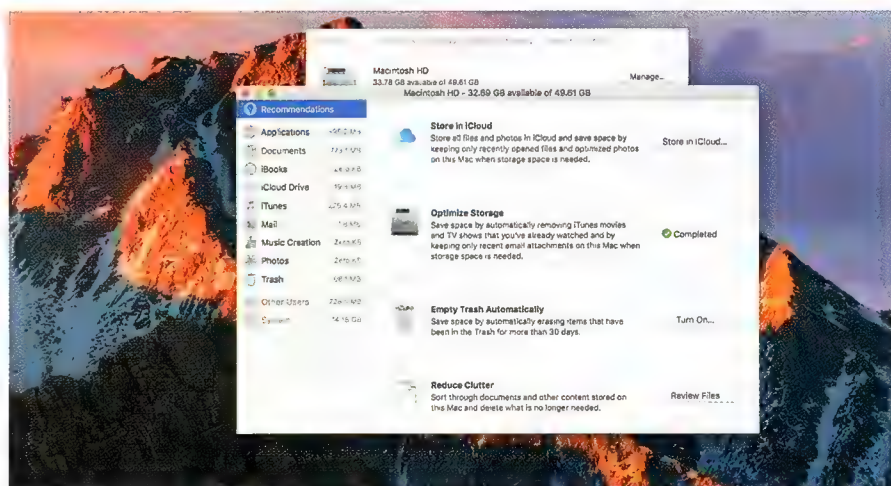
8 SMART SEARCH IN PHOTOS

The Photos app in macOS Sierra now uses new technology to identify objects and scenes. For instance, you could type 'birthday cake' or 'car' to find images that fit into that category. To get started, simply click the search bar in the top-right corner of the app,

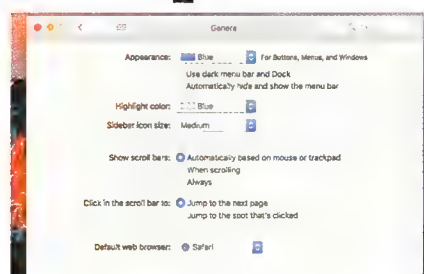
and enter your text. While this new feature is exciting, it isn't foolproof, and it likely never will be. During our tests, for example, when searching for the term 'car', it displayed all related images, except for one of a car against a snowy backdrop.

9 REMOVE CLUTTER

Over time, your Mac may become overloaded with various files, which can impair system performance.

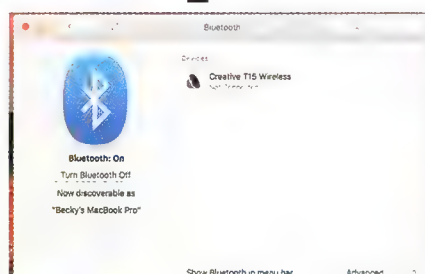


Set up Universal Clipboard



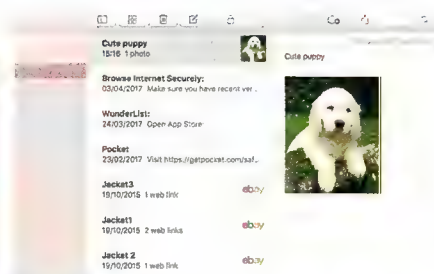
1 ENABLE HANDOFF FIRST

Click System Preferences > General. Tick 'Allow Handoff between this Mac and your iCloud devices'. Go to Settings > General > Handoff on your iOS device and activate it.



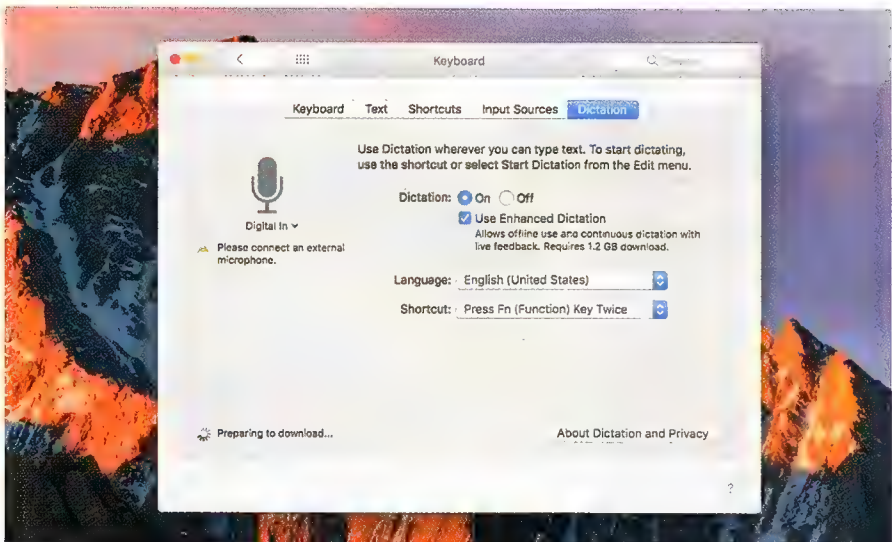
2 ENABLE CONNECTIVITY

On your iOS device, go to Settings and check Bluetooth is 'on' and you're connected to Wi-Fi. On your Mac, go to System Preferences > Bluetooth and enable it as well.



3 USE UNIVERSAL CLIPBOARD

Find some text, a photo or a video to copy. Either Control-click or press, and hold on it and choose Copy. You can now paste it on the other device, provided the two devices are in the same vicinity.



If you're using macOS Sierra, you can quickly resolve this by clicking on **Apple > About this Mac** and choosing the **Storage** tab. This will display the amount of free space and what kind of data has been stored, such as images.

Click on the Manage button to try to save some precious space. These options are fairly self explanatory. Start by examining the left-hand pane

to see how much space is taken up by certain apps, like iTunes. If you download a lot of media files, you may wish to turn on the Optimise Storage option, which automatically removes iTunes movies and shows you've already watched.

The 'Store in iCloud' option is designed to work in harmony with iCloud Drive. It uploads the contents

of your Desktop and Documents folder to iCloud, keeping only recently opened files on the Mac itself. If you have multiple Macs, this is also an excellent way to keep all your files in sync across various computers.

Click the 'Turn On' button to remove items that have been there for more than 30 days.

You can also click on 'Review Files' to show documents and data in order of size. This may be helpful for removing old data. Make sure you run a backup before deleting anything.

10 ENHANCED DICTATION

The basic dictation feature in macOS transcribes your speech into compatible apps. Begin by going to System Preferences > Keyboard. Click on the Dictation tab, then on the radio button to switch Dictation on. If you're using macOS Sierra, you can also use Siri and say "turn on dictation". Your Mac must be connected to the internet to use dictation, as your words are sent to Apple to be converted to text. This has privacy implications, and can be very slow. Click the check box marked 'Enhanced Dictation' to enable offline dictation. This also allows for continuous speech as well as support for dictation commands. (For a full list, see bit.ly/dictation_commands).

 SIGN DOCUMENTS IN PREVIEW

 Preview allows you to add handwritten signatures to documents and images. Open a document using Preview, then click on the Tool menu at the top of the screen. Choose Annotate > Signature > Manage Signatures. A new pop-up window will open.

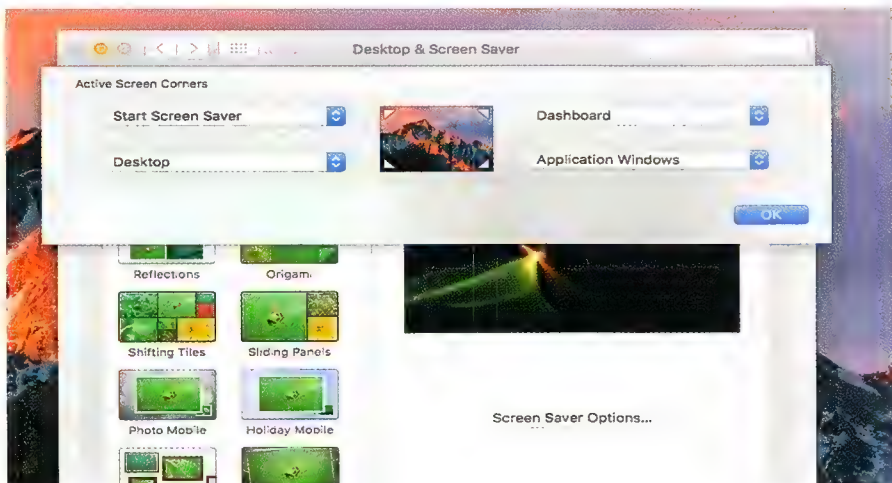
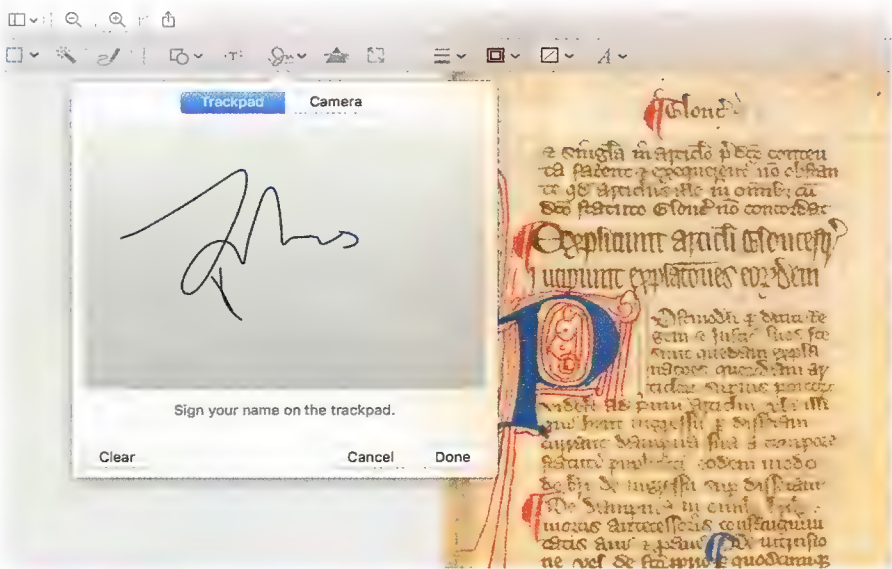
When you're ready, choose 'Click here to begin' and use the trackpad to trace your signature. You can also use the Camera tab to create a signature using iSight if you prefer. Click Done to save your signature. You will now be able to insert this into documents.

 HOT CORNERS

Hot Corners enables you to activate functions by moving the cursor to a corner of your screen. This can increase your productivity, as you no longer have to remember shortcuts.

Go to **Apple > System Preferences > Desktop and Screensavers**, then click the **Screen Saver** tab. Find the **Hot Corners** button in the bottom right, then click on it.

An Active Screen Corners window will open. You can assign a function to any corner via the dropdown menu, then simply move your cursor to it to activate the feature. ■



Master Pages for iOS's new features

Take advantage of new formatting tools, bookmarks and more in Pages for iOS.

In 2014, Apple revamped its iWork office suite by 'dumbing down' the Mac version to bring it in line with the less powerful iOS iteration. Happily, since then, it has restored missing features and added new ones, with iPad users gaining many excellent tools for the first time.

Pages 3.1 for iOS is in this vein. It has new text formatting tools, including superscript and subscript formatting options, support for ligatures (see 'Make use of ligatures' opposite) and background colour control.

When writing long documents, it helps to be able to rapidly navigate them. Our second step-by-step guide will show you how to use Pages' new Bookmarks feature to move quickly between the different parts of a document, which you specify.

WORDS AND NUMBERS

Mathematicians will be pleased to discover that Pages now supports equations through LaTeX commands or MathML elements – our final step-by-step guide here reveals how the formatting and markup tools work. Other changes are minor. When you protect a document by tapping the three dots (...) icon and choosing 'Set Password'. For example, you can now choose to protect it using Touch ID.

MORE NEW FEATURES

You can customise dates, times and currencies for different languages and regions. First, go to Settings > General > Keyboard to enable a second keyboard, then once done tap '...' in Pages and choose 'Language & Region' to make the switch.

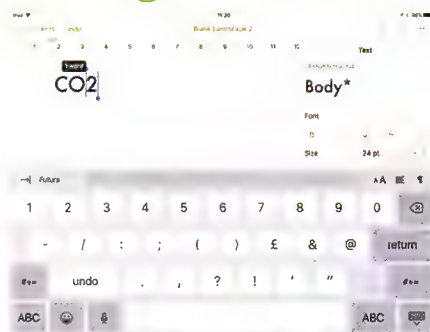
Pages 3.1 also supports both importing and exporting documents in the popular Rich Text Format (RTF), and claims to make it easier to swap out missing fonts. When you open a document that contains fonts that are unavailable on iOS, look out for a brief warning at the top right of the screen; tap it to see which are missing, then 'Resolve Font Warnings' only if you're OK with substituting Helvetica.

When creating pie charts, you're now given the opportunity to add new leader lines for clear labelling. Tap 'Value Labels' inside the Format inspector's Chart pane, then choose to position them 'Outside' to reveal three options: none, straight and angled.

"When you open a document that contains fonts that are unavailable on iOS, look out for a brief warning at the top right of the screen; tap it to see which are missing, then 'Resolve Font Warnings' only if you're OK with substituting Helvetica."

How to

Use Pages' new formatting tools



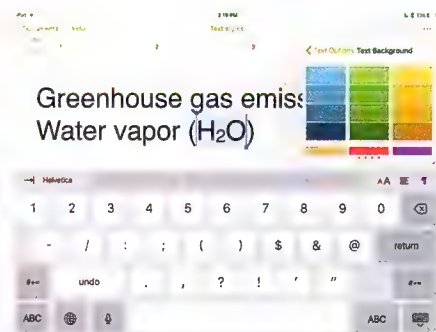
1 SUB/SUPERSCRIPT

There are two ways to apply these to your document. If you haven't typed the character or word, skip to step two; otherwise, you need to select the character or word using Pages' selection tools. Tap the brush icon.



2 APPLY FORMATTING

Tap the three dots (...) in the row below the font name to see text options. Next, tap the superscript or subscript option under Baseline to format what's selected or what you're about to type in that style.

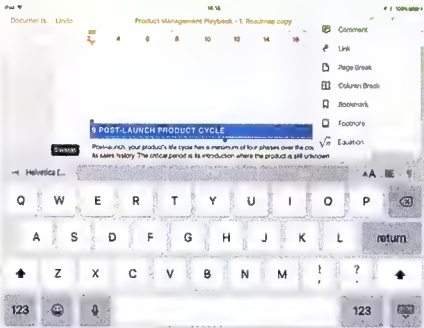


3 TEXT PAPER COLOUR

Select your text, tap the brush and then the three dots (...) as before. This time, scroll down to the bottom of the Text Styles pane and tap 'Text Background' — swipe horizontally on the colour picker for more options.

How to

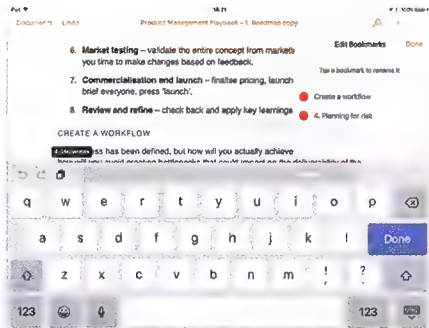
Navigate large documents



1 ADD BOOKMARK
Bookmarks can only be applied to text. Select the text you'd like to turn into a bookmark, then tap the button above the on-screen keyboard and choose Bookmark. The text will briefly be highlighted with a yellow box.



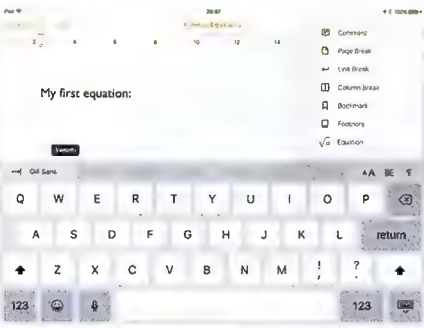
2 LINK TO BOOKMARK
Select some text, tap , then 'Link'. Tap 'Link To' and pick Bookmark. Tap the Bookmark row to choose a target; if the suggestions don't show what you're looking for, tap 'Manage Suggestions' to set which styles are included.



3 JUMP, EDIT, REMOVE
Tap the three dots (...) button at the top right and choose Bookmarks. A list of all bookmarks in the current document appears. Jump to a bookmark by tapping it, or tap 'Edit' to rename bookmarks or delete them.

How to

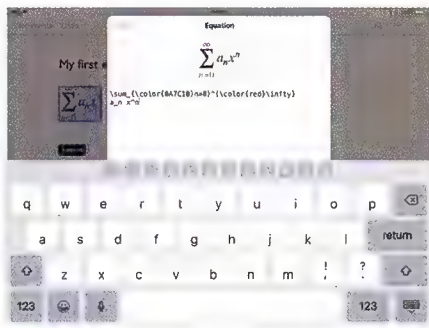
Embed equations in Pages



1 INSERT EQUATION
Place the insertion point where you want your equation to go, then tap the button on the on-screen keyboard and choose Equation (swipe up if needed). The equation editor will open in maths mode by default.



2 SUPPORTED SYNTAX
The equation editor supports some LaTeX and MathML — see [apple.co/2pJpTXx](#). To type a grey symbol (from a 9.7-inch and 7.9-inch iPad's keys), drag down from it, left or right (if there are two symbols), then let go.

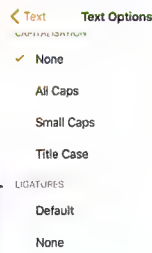


3 PREVIEW AND INSERT
As you type, a preview of your equation will appear in the editor. If an error is displayed, check your equation to make sure it's correct. Once finished, tap Insert. To edit an equation, double-tap it in your document.

Make use of ligatures

Give your documents the handwritten look.

Certain fonts, including Zapfino, include special versions of regular characters known as ligatures that create the illusion of cursive writing. In Pages 3.1, you can now control how supported fonts use ligatures. To see what — if any — effects are available with a specific font, select a passage of text, tap the brush icon to open the inspector, then tap the three dots (...) under the font name and scroll down to the Ligatures section. The Default setting uses a smattering of ligature characters to balance readability and decoration, or you can choose None or All. ■





The Big Ripper rendering rig

It's time to create some content — which means it's also time to build a monster machine with Zak Storey.

THE CONCEPT

It's about time we put those rendering processors to work, huh? We certainly think so — 16 cores and 32 threads are just too good an opportunity to pass up. And with a renewed push to produce more video content for our publisher Future's online properties over the coming months, it makes sense to piece together a workstation for our online team that's a little more spec-driven than the Core i7-5820K and 32GB of DDR4 he has now.

At APC, our workstations are

generally constructed out of parts we have on loan, they need to be flexible, and easy to take to pieces if certain components have to go back to their PRs. They also need to be versatile — from gaming, to standard office work, to photo editing, video rendering, and running through all manner of tutorials, our rigs have to be capable of doing it all.

This time around, our system is going to have a very large focus on video editing, so the monster component that is Threadripper is our

processor of choice. Whether it's the 8-, 12-, or 16-core parts, both the connectivity and quad-channel memory support, combined with Ryzen's architectural prowess, make it the perfect match for our rendering aspirations, and anything else we want to throw at it.

So, what's the plan? Grab the 1950X, an ASUS Prime X399 motherboard, 128GB of DDR4, a plethora of PCIe solid-state storage for scratch disk and OS use, and 20TB or so of hard drives for backup. No biggy, right?

TRULY TITANIC

The one thing we really enjoy about specing systems like this is just how much they change over the course of the planning stage. First, we were going to use the 12-core Threadripper, and we decided the ASUS Zenith Extreme was our motherboard of choice. NZXT promised us a swanky new chassis exclusive... which, unfortunately, didn't arrive in time, so we swapped to the Fractal Design Meshify, but that wouldn't support the ASUS Prime X399-A we eventually went with, so we finally settled on our old favourite, the Evolv ATX, instead. Couple that with the drop in effective memory frequency from 3,200 to 2,933, and that's one hell of a lot of different tweaks and changes to how this system was originally going to shape up.

It's a monstrous beast, and at almost \$10K it has a price tag to match. For most of us, that'll admittedly be an outlandish amount of money to invest in any kind of build.

The problem, as is often the case with these builds, lies with the storage and memory. As core counts have increased, and graphical prowess has accelerated headlong into the clouds, maximum memory capacity and hard drive prices have faltered. Look back two years, and the rate of improvement pales in comparison. That said, if you want to make this build more affordable, you could shave a good \$2,000 off just by lopping off some of that excess storage. Even cutting down the memory to 64GB at 2,933 would save you nearly \$900.

PARTS LIST

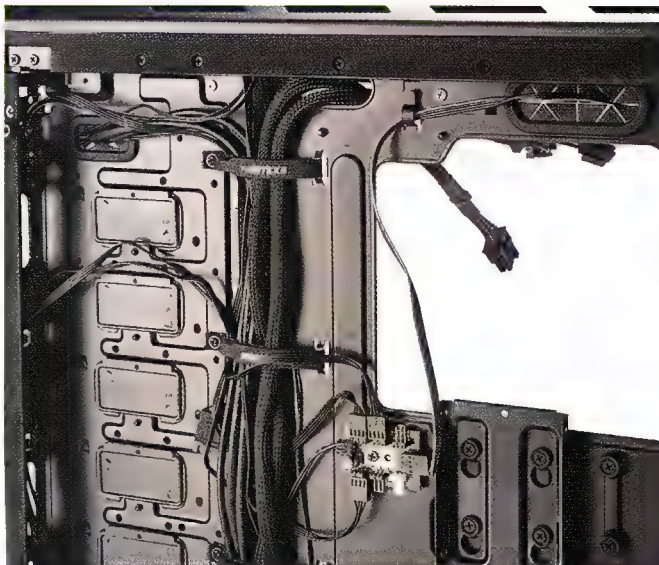
PART		STREET PRICE
CASE	PHANTEKS ENTHOO EVOLV ATX TG - BLACK	\$290
MOTHERBOARD	ASUS PRIME X399-A	\$620
CPU	AMD RYZEN THREADRIPPER 16-CORE	\$1,440
MEMORY	128GB (8X 16GB) G.SKILL TRIDENTZ SERIES 3,200MT/S	\$1,780
GPU	EVGA GEFORCE GTX 1080 TI	\$1,150
PSU	CORSAIR RM1000X 1,000W	\$260
STORAGE 1	1.2TB INTEL 750 PCIE SSD	\$1,600
STORAGE 2	1TB CRUCIAL MX300	\$450
STORAGE 3	2 X 10TB HGST HE10 7,200RPM	\$1,440
COOLING	NZXT KRAKEN X62 280MM AIO, 2 X CORSAIR ML 140 PRO, 4 X CORSAIR ML 120 PRO	\$440
OS	WINDOWS 10 HOME	\$130
TOTAL		\$9,600

The monster component that is Threadripper is our processor of choice.



1 FAN-TASTIC

Phanteks's Evolv ATX TG has exceptional cooling support. Designed with liquid cooling in mind, it features a unique sliding radiator bracket in the roof, along with a whole ton of support for additional fan mounting. The front of the case allows for the external installation of up to three 120mm fans, between the chassis and the front fascia panel, typically used when installing a radiator. If you're installing fans without a rad in the front, to save space (for example, if you have two 3.5-inch hard drives installed below the PSU cover), you have to mount the fans from the rear instead of the front, as you would traditionally.



2 CABLE CONUNDRUMS

We knew going into this that, by default, the Phanteks Enthoo Evolv ATX TG is only meant to support ATX-sized motherboards. It can accommodate the larger form factor, but only with careful planning. Because the motherboard will cover the rubber grommets used for cable management, it's important in this scenario to install both the power supply and the cables you're going to need first, before installing and securing the motherboard in place. This actually gives us a good opportunity to work on our cable management ahead of time — important, given the Evolv ATX TG's clear rear glass panel.



3 TRIUMPHANT THREADRIPPER

Installing the 16-core beast is daunting. Upon purchase, you receive an Asetek bracket for your AIO and a torque screwdriver. Using the screwdriver, you undo screw three, screw two, then screw one. Let the first retention bracket lift up, then gently pull the two blue tabs up at the top of the socket. With the second retention bracket, slide out the plastic cover, then carefully remove the additional cover protecting the socket. Slide Threadripper into the second retention bracket until it clicks into place, then gently lower it on to the LGA socket, finally resealing the top retention bracket by tightening each screw until the included screwdriver clicks, going from screw one, to two, to three.



5 PCIe PROWESS

Although we now have access to a couple of beautiful Titan Xps, we've decided to stick with the Nvidia GeForce GTX 1080 Ti — it's a beauty, and although it doesn't quite reach the pinnacles of performance that the Titan does, it's more than good enough for all our rendering and lunchtime gaming needs. We've also decided to pull out an old favourite — Intel's 1.2TB 750 PCIe SSD — for our primary storage drive and scratch disk. Although we're not massive fans of PCIe add-in cards like this, particularly for storage, the performance is exceptional, and that extra capacity is going to work wonders for us.



4 CLOSE ENCOUNTERS OF THE CABLE KIND

This was always going to be a tight build, given the meaty mobo and the 280mm Kraken X62 wedged into the top of the chassis. Fortunately, thanks to the Evolv's removable radiator bracket in the top, this stage of the build is less stressful, especially when installing the multiple cables going into the Kraken X62 CPU block and routing fans into the motherboard. Slide the bracket out halfway, and you can easily reach around and gain access to the top of the board. It was also convenient when we first booted the board, because the stock BIOS on our review sample didn't support all 128GB at any frequency — one slide out, four sticks removed, a BIOS update and reinstall of the RAM later, and we're all good.



6 SMART MOUNTING SSDS

Any opportunity to use a magnetic LED strip and we'll take it. Given the nature of this build, it doesn't really need the extra lighting inside — if anything, it's just adding additional power draw. That said, because power draw isn't a primary concern for us here, and it's going to be sitting on our desk, why not? We've also routed the cables for the Crucial MX300 around the right-hand side of the SSD, to ensure that we can retain the label in the correct orientation. It is a little snug to plug those cables in, but once installed, they're not going anywhere.



1 Seen from the side, it gives you a clear idea of just how big that motherboard is, covering up more than half the cable grommets in the process.

2 AMD's latest processors are actually fairly cool, so a 280mm AIO is plenty for a stock Threadripper.

3 The one thing we do wish is that the rear panel was made from smoked glass, instead of being transparent, as it lets a lot of light in from the back.

4 No flashy cables on here — just simple and stock. That said, those all-black cables do add a certain style to the build, matching the tubing on the AIO.

Ripping up the opposition

It's nice to have a build that comes together so smoothly. No hassle, no mess. The most challenging part was installing the three front 120mm fans from the inside, instead of externally. The radiator bracket in the roof made AIO installation a dream. The motherboard, despite pre-routing the cables, fitted snugly in place, and the fully modular 1,000W PSU reduced cable clutter.

It's not flawless, but for all intents and purposes, it's perfect for the job at hand. The biggest decisions came from swapping and changing the spec list, and little else. And that's the problem: With Threadripper, AMD has introduced a way for mainstream consumers to gain access to HEDT features far greater than anything

we've seen previously. With 64 PCIe lanes directly connected to the processor alone, allowing for up to four-way CrossFire or SLI at x16/x16/x16/x16, it's staggering what you can do.

Alongside that, the number of cores is unprecedented within the industry. And although Intel does have solutions in the pipeline, they're coming in at a minimum of \$1,000 more, as standard. And they don't support the insane levels of PCIe lane connectivity we've witnessed here with TR.

This puts Threadripper in a unique position because, although the core architecture isn't quite up to scratch compared to Intel's well-honed design right now, having that many cores, at such an affordable price, with a fairly

weighty chipset behind it, makes it far more accessible and powerful than anything we've ever seen from Team Blue. For instance, ignoring our ridiculously pricey build here (thanks again, storage), you can knock up a fairly impressive 12-core, 24-thread, 32GB system for less than \$3,600 relatively easily — check out our recommended build for that at tinyurl.com/apc447-pcpp.

Going forward, bearing in mind that these processor parts are based on AMD's EPYC server chips, it's entirely feasible that we could see core counts reaching even higher than the 16 cores we have today. A 32-core part coming out to directly combat Intel's 18-core Core i9-7980XE at the same price point may seem outlandish, but it's definitely something that's on the table for Team Red right now, and it would secure its absolute dominance in the high-end desktop domain.

Finally, let's make one thing clear: You can game, very comfortably, on Threadripper, outside of gaming mode, at 1080p, 1440p, and above, with relative ease. The difference between Intel and AMD is definitely there, but it's marginal (3-4 % difference at most), and unless you absolutely must be at the cutting edge for frame rates, you're not even going to notice. ■

BENCHMARK RESULTS		
	APC LABS TEST PC	THIS SYSTEM
CINEBENCH R15 MULTI-THREAD	987	3,362 (240%)
CINEBENCH R15 SINGLE-THREAD	196	160 (-18%)
TECHARP'S X264 HD 5.0.1 (FPS)	21.93	72.68 (231%)
CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)	1,895	2,560 (35%)
CRYSTALDISK QD32 SEQUENTIAL WRITE (MB/S)	949	1,334 (41%)
RISE OF THE TOMB RAIDER (FPS)	41	91 (122%)
THE DIVISION (FPS)	78	125 (60%)
3DMARK: FIRE STRIKE (INDEX)	15,026	22,819 (52%)

Our desktop APC Labs Test PC uses a Core i7-6700K CPU @ 4.6GHz, an AMD R9 Fury X, and 32GB of RAM. All games are tested at 1080p on max settings, with HD texture packages installed.

Safely store cryptocurrency on a Raspberry Pi

Put your Bitcoins on ice and use a Raspberry Pi as a cold wallet to store all your digital currency safely offline.

As you're probably aware, the cryptocurrency Bitcoin can be used to make anonymous and irreversible online payments, similar to hard cash. Bitcoin is a huge leap forward for privacy-minded people, but the fact that it's a digital currency means that hackers often target owners of Bitcoin software wallets. In this tutorial, we'll explore a solution using the lightweight Bitcoin Wallet Electrum on the Raspberry Pi. The Pi will host a 'cold' wallet which is kept offline at all times.

You'll also set up an online 'watching' wallet on another computer so you can see payments as they come in. Payments are only sent by generating a transaction file with your watching wallet, which you transfer manually via a USB stick to your 'cold' wallet to be digitally signed.

As your cold wallet is offline, only people with physical access to it can make payments, which enables you to store Bitcoins safely.

This guide assumes that you are familiar with the basics of Bitcoin. If not, then visit this useful introduction page bit.ly/2m7Ct2X for a rundown.

1 INSTALL SOFTWARE

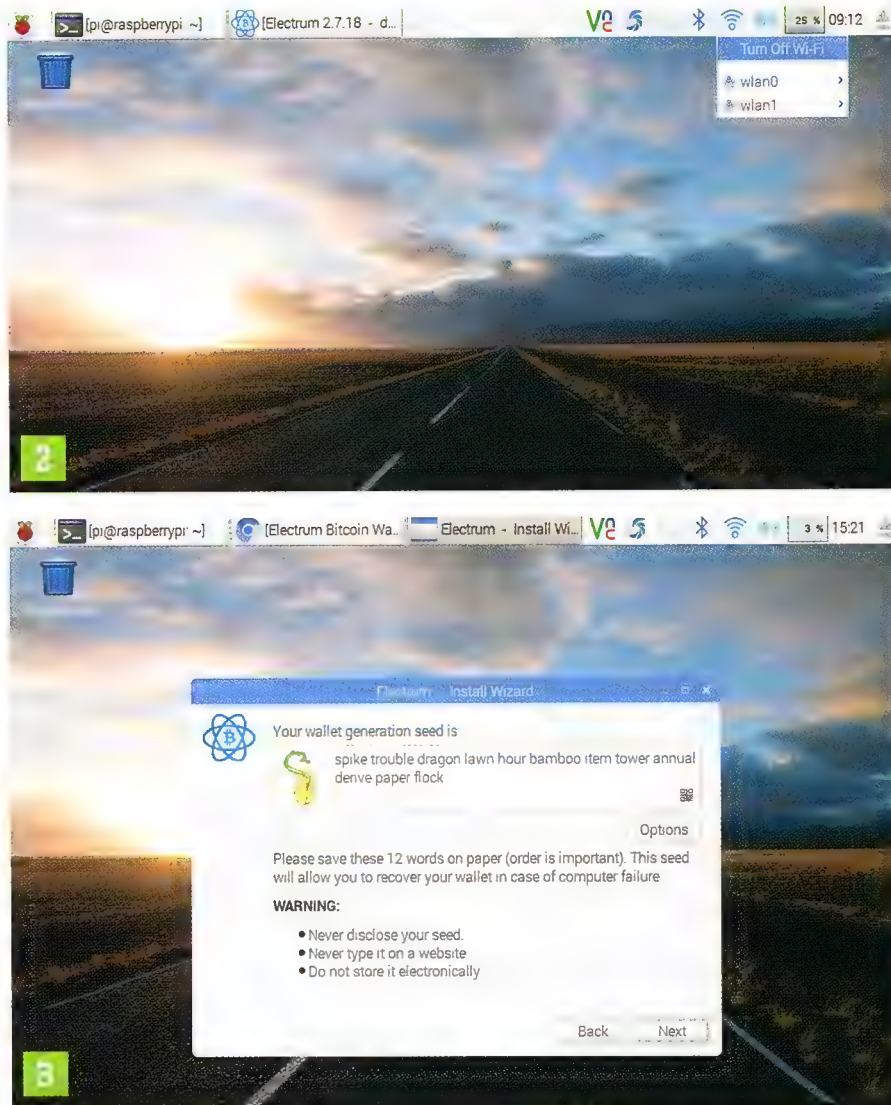
Connect the Pi to a screen and keyboard. Open Terminal and run these two commands:

```
sudo apt-get update
sudo apt-get upgrade
```

For security reasons, you should only use this Pi as a wallet for future purchases.

The Raspbian repositories (repos) have an old version of the Electrum wallet, but it is best to download the latest version manually.

Next, run the following two commands to install the latest wallet software with `sudo apt-get install python-qt4` then `sudo pip install download.electrum.org/2.7.18/Electrum-2.7.18.tar.gz`.



2 DISCONNECT FROM THE INTERNET

This step is essential for ensuring your wallet is safe. Remove any network cables and/or Wi-Fi adaptors connected to your Pi. If you use a Pi 3, simply click on both the wireless and Bluetooth icons on the Pi and choose 'Turn off Wi-fi' and 'Turn off Bluetooth', respectively. Keep your Pi connected to a monitor and keyboard, as you'll need this for sending payments later. Once you're offline, run the command `electrum` in Terminal to start the wallet.

3 GENERATE WALLET SEED

Choose 'Auto Connect' on the first Electrum window, then click 'Next'. On the next screen choose a 'standard' wallet and 'Create a New Seed'. Electrum generates 12 random words for wallet seed and do as the program requests and write these down on paper. These random words will enable you to restore your wallet if anything happens to your Pi. Click 'Next' to continue.

4 CONFIRM AND STORE WALLET SEED

Use the words you wrote down earlier to retype your wallet seed. Remember that in the wrong hands, the seed can be used to steal from you, so store the paper in a safe place or, better yet, memorise the words. Try using the Loci method to memorise the words by associating them with places in a familiar location such as your home.

5 CHOOSE YOUR WALLET KEY PASSWORD

After confirming the wallet seed you can optionally set a password to protect this copy of the wallet on the Pi. You'll need to re-enter this password when sending Bitcoins. Ideally choose a password that's at least 10 characters long with a mixture of letters, numbers and symbols. Electrum alerts you if a password is weak, moderate or strong. Do not use any of the words in your wallet seed for the password.

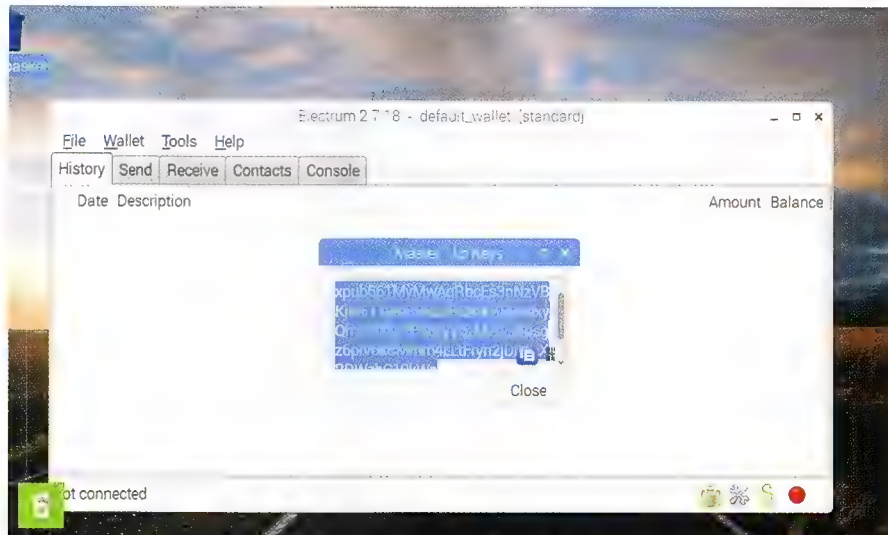
6 EXPORT MASTER PUBLIC KEYS

In the Electrum Wallet, click the 'Wallet' menu option then 'Master Public Keys'. This will generate a string of text that you'll use on a separate computer for your 'watching wallet' so you can receive payments.

Click the blue icon to copy the key then go to Applications > Accessories > Text Editor to paste it into a text file. Insert a USB stick and save the new text file to it.

7 INSTALL WATCHING WALLET

Safely eject the USB stick from the Pi and insert the stick into the computer that you want to use for your 'Watching Wallet'. Electrum works on most platforms but for security reasons, and because we'd always recommend GNU/Linux over



any other platform, place your watching wallet on a spare Linux system, if possible.

If you're using a Debian-based distro like Ubuntu, repeat Step 1 but make sure that you install python-pip as well as python-qt4. For other platforms follow the instructions at electrum.org/#download.

8 RESTORE MASTER KEYS

Launch the Electrum client on your online machine. In Linux, you can simply run electrum from the Terminal. Choose 'Auto Connect' once again on the first screen and click 'Next'. Click on the 'standard wallet' option once again and then on the 'Keystore' screen choose 'From Public or Private Keys'. On the next screen, paste in the master key in the text file from your USB stick. Read the warning and click 'OK'.

9 SET UP ADDRESSES

Electrum will now generate addresses for you and when the main window opens click on the 'Receive' tab

to view your address. You'll see both a text string and a handy QR code for your new address. Type a description for your receiving address if you wish, then click 'Save'. You can generate more addresses later.

10 TEST WALLET ADDRESS

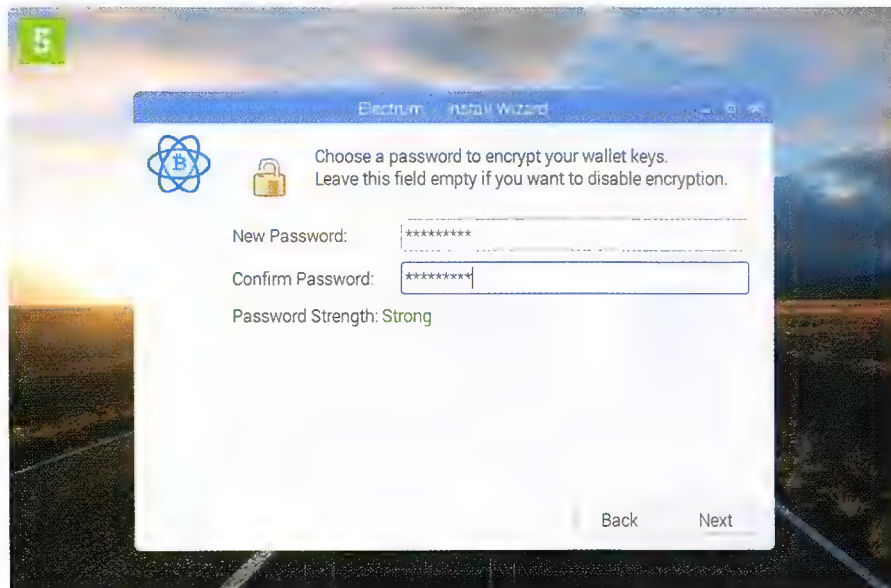
Using your current Bitcoin wallet, try to send some funds to your new wallet address. If possible, use a client which supports scanning QR codes, so there's no danger of getting the address wrong.

Once the payment is sent, the unconfirmed new balance should show in the bottom-left corner of the Electrum Window. Now, you'll need to wait until the balance is confirmed before proceeding.

11 SET UP SENDING

Now that you can receive funds, it is time to test if you can send them. Find your recipient's wallet address. For this tutorial, we are using the Bitcoin Address of the Electronic Frontier Foundation (EFF) to send a donation.

Click on the 'Send' tab in Electrum and paste the address into the 'Pay to'



Anonymise your net connection

By default, anyone snooping on your connection can see your IP address connecting to the Electrum servers. Your IP could be used to link your identity to specific addresses in your 'watching' wallet. If you have Tor running on your system, you can route Electrum's connection through the Darknet by going to Tools > Network. Select 'SOCKS5' as your 'Proxy'. The rest of the information is filled in already, so just click 'OK'.

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field. Add a description if you want to and then click 'Preview'.

12 SAVE TRANSACTION

Click 'Save' in the new window to save the TXN (transaction) file and navigate to your USB stick and place it there. Electrum confirms that the transaction is saved successfully. You can click 'Close' to shut down the window. A transaction needs to be digitally signed by the cold wallet on your Pi to send the funds. Safely eject the USB stick from your online computer and connect it to the Pi. from your USB stick. Read the warning and click 'OK'.

13 SIGN TRANSACTION

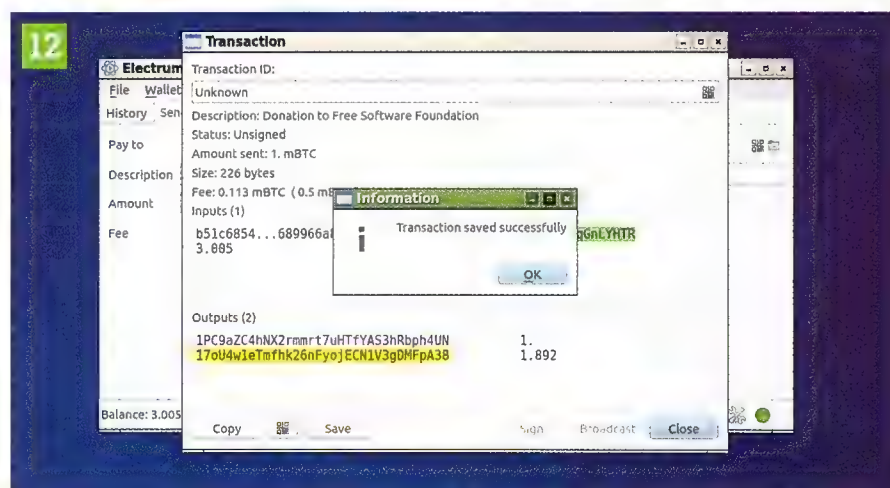
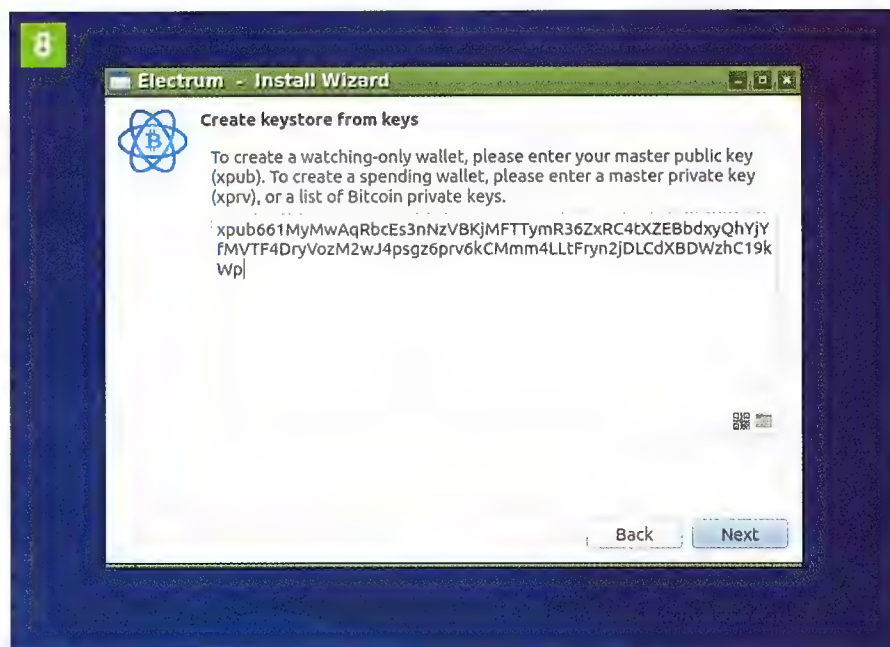
Open the Electrum client on your Pi and click on the 'Tools Menu'. Select Load Transaction > From File and navigate to the transaction file on the USB stick.

Details of the transaction will load. Check everything is in order then click 'Sign'. Enter your wallet password. Click 'Save' to store the newly signed transaction file to the USB stick. Click 'OK', followed by 'Close' and safely eject the USB stick from the Pi.

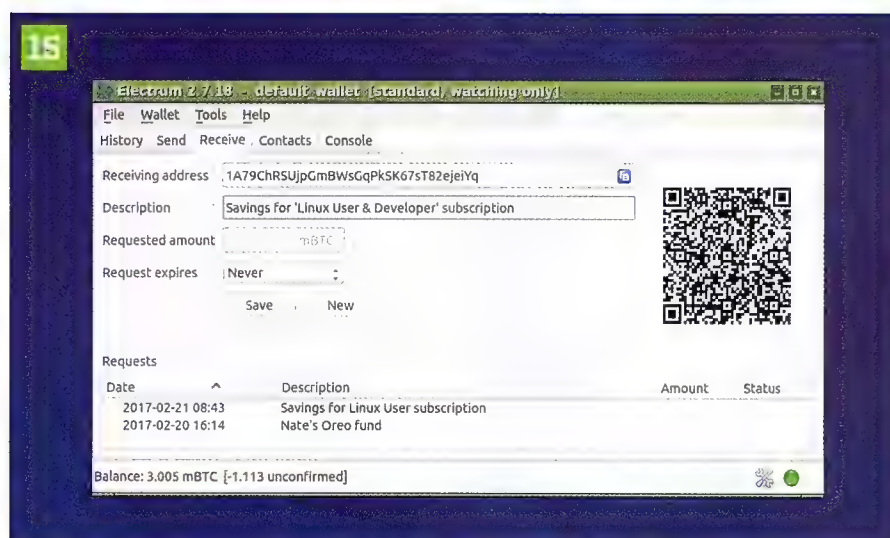
14 BROADCAST TRANSACTION

Next, you'll need to insert the USB stick to your computer with the 'watching' wallet. Open Electrum and click Tools > Load Transaction > From File. Choose the signed file on the USB stick. A new window opens with the transaction details. Double-check these and click 'Broadcast' to send them to the Bitcoin network.

You will see a confirmation message.



"To prevent your Bitcoin transactions from being traced, you should generate a new address for receiving each payment."



Click 'Close' to see the unconfirmed amount in the Electrum window. The processing times for a transaction will vary based on the fee that you paid.

15 GENERATE NEW ADDRESSES

To prevent your Bitcoin transactions from being traced, you should generate a new address for receiving each payment. In the 'Receive' tab of Electrum, click 'New' to create a new one. Enter a description if you like and click 'Save'. You can move between different wallet addresses from the 'Requests' pane. Repeat Steps 10-14 to receive and send funds from this new address.

Having worked your way through this tutorial, you'll now have a 'cold' wallet set up, a method for making payments and an online 'watching' wallet for tracking payments. ■



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Make a secret killswitch for your Raspberry Pi

Keep your data safe with a handy 'nuke' password to erase your home folder in case of emergency.

If you're worried about the somewhat Orwellian notion of a forced disclosure of passwords, this coding project posits a rather radical solution to the dilemma: create a second password for your user account, which, instead of logging you in, will nuke your home folder using special tools.

As extreme as this sounds, it's surprisingly simple to set up. A couple of disclaimers: make sure to back up your personal data to a safe place before going ahead with this project. Also bear in mind that it's not an infallible method, as anyone with physical access to your machine may seize it before you have a chance to flip this killswitch.

1 CREATE YOUR NEW USER ACCOUNT

Although you most likely will already have a user account on the Pi, create a new one for this project by opening Terminal on your Pi or connecting via SSH and running the command

```
sudo adduser name
```

Add your new user as an Administrator with:

```
sudo adduser name sudo
```

Substitute "name" with your chosen username.

2 CREATE YOUR NUKE SCRIPT

You should stay logged into the 'Pi' user for now and run the following command:

```
sudo nano /etc/security/security.sh
```

In the new window, paste the following:

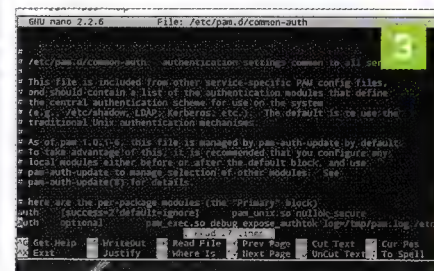
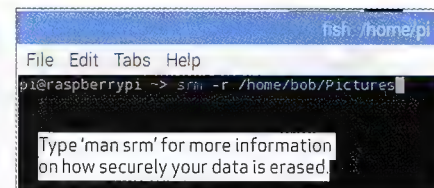
```
#!/bin/bash
read password
# If the username and
password match...
if [ "$PAM_USER" = "name" ]
&& [ "$password" =
"nukepassword" ]
then
#Begin Nuke Process
```

```
pi@raspberrypi -> sudo adduser alice
Adding user 'alice' ...
Adding new group 'alice' (1001) ...
Adding new user 'alice' (1001) with group 'alice' ...
Creating home directory '/home/alice' ...
Copying files from '/etc/skel' ...
Enter new UNIX password:
Retype new UNIX password:
passwd: password updated successfully
Changing the user information for alice
Enter the new value, or press ENTER for the default
Full Name []: Alice Smith
Room Number []:
Work Phone []:
Home Phone []:
Other []:
Is the information correct? [Y/n] Y
pi@raspberrypi -> sudo adduser alice sudo
Adding user 'alice' to group 'sudo' ...
Adding user alice to group sudo
Done.
pi@raspberrypi -> █
```

Hidden extras

In addition to the srm command in the nuke script, which securely erases the home folder, you may have noticed that there are two other commands, sfill and smem. Remove the # at the start of these lines to overwrite the free space in the /home folder and clean any files in the Pi's virtual memory (RAM), respectively. This will take much longer than the srm command on its own but is a good deal safer.

```
echo "Nuke is starting."
#Securely erase the home
folder
srm -rvvv /home/name/
echo "Home folder has been
erased."
#Overwrite the /home folder
with random data
#sfill /home
echo "Home folder has been
overwritten"
```



```
#Clean RAM memory
#smem
echo "RAM is clean"
echo "User data has been
nuked."
fi
exit 0
```

3 MODIFY THE SCRIPT

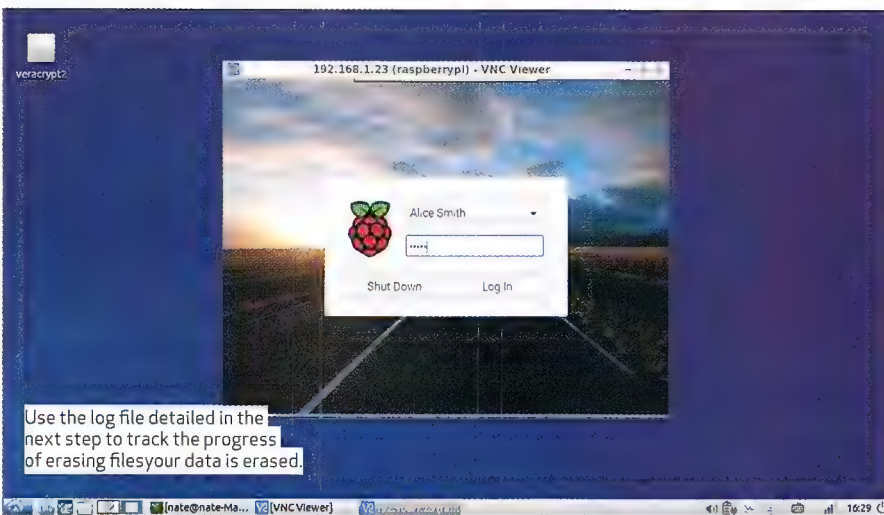
In Line 5, substitute 'name' and 'nukepassword' for the username of


```
pi@raspberrypi ~-> sudo apt-get install secure-delete
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
  secure-delete
0 upgraded, 1 newly installed, 0 to remove and 1 not upgraded.
Need to get 67.9 kB of archives.
After this operation, 112 kB of additional disk space will be used.
Get:1 http://mirrordirector.raspbian.org/raspbian/ jessie/main secure-delete a
hf 3.1-6 [67.9 kB]
Fetched 67.9 kB in 0s (70.9 kB/s)
Selecting previously unselected package secure-delete.
(Reading database ... 128013 files and directories are currently installed)
Preparing to unpack .../secure-delete_3.1-6_armhf.deb ...
Unpacking secure-delete (3.1-6) ...
```

```
File Edit Tabs Help
GNU nano 2.2.6 File: /etc/security/security.sh Modified

#!/bin/bash
read password

# If the username and password match...
if [ "$SPAM_USER" = "alice" ] && [ "$password" = "orange" ]
then
#Begin Nuke Process
echo "Nuke is starting."
#Securely erase the home folder
srm -rvvv /home/alice/
echo "Home folder has been erased."
#Overwrite the /home folder with random data
#sfill /home
echo "Home folder has been overwritten"
#Clean RAM memory
#smem
echo "RAM is clean"
echo "User data has been nuked."
fi
File Name to Write: /etc/security/security.sh
```



your new account and the desired nuke password. Make sure this is different to your current one. Change 'srm -rvvv /home/name/' to the path of your real home folder.

4 RUN NUKE SCRIPT ON LOGIN

Make your nuke script executable with the command:

```
sudo chmod a+x security.sh
```

Next, run...

```
sudo nano /etc/pam.d/common-auth
...to open the Pluggable
Authentication Modules (PAM).
```

Find the line starting 'auth [success=1...]' and change this to 'auth [success=2...]'.

Immediately below this line, paste the following:

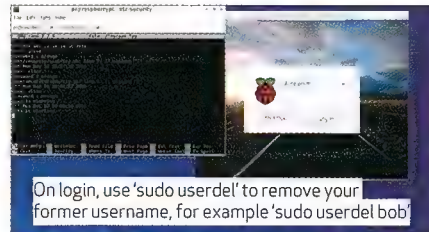
```
auth optional pam_
exec.so expose__ authtok

log=/tmp/pam.log /etc/
security/security.sh
```

5 INSTALL SECURE DELETE TOOLS

Run the command...

```
sudo apt-get install secure-
delete
```



...to install the tools necessary to erase your home folder securely. Substitute 'name' with your chosen username.

6 MIGRATE YOUR DATA (OPTIONAL)

If you previously had personal data in another user account, you should take this chance to move data across from that account to another from your backup drive. If you wish to delete the originals, do so using the new secure-delete tools, for instance:

```
'srm -r /home/bob/
Pictures'
```

7 TEST YOUR NEW ACCOUNT

Reboot your Pi and log into your new user account using the normal login password. Check that your files are where you need them.

8 TEST YOUR NUKE SWITCH

If your data is backed up, there's no harm checking your nuke password works. Reboot the Pi once again. Select your new username and enter the nuke password. The system will hang while it removes your files.

9 CHECK NUKE LOGS

You can still connect to the Pi via SSH while the nuke script is running. Use the command...

```
cat /tmp/pam.log
```

...to check the progress of the nuke. Any further attempts to log in will just take the user back to the login screen. ■

Why Android Oreo is a game-changer

Version 8.0 of the popular Google operating system has landed, but with one fundamental change to benefit us all – eventually. Darren Yates explains.

Much has already been made regarding the arrival of the latest version of Android, from improved notifications and faster boot times to 'picture-in-picture' dual-app capability. But make no mistake – it's easy to think this is just another Android release, however, Oreo/8.0 is as fundamental a shift in thinking for Android as we've seen. Plenty of new Android OS releases have come and gone, but this is the one that could change the future of Android. If Google gets it right, Oreo will be the beginning of the end for the Android ecosystem's greatest bugbear – the OS update lottery.

ANDROID COMET TALE

Head online to the Android Developers' Dashboards page (tinyurl.com/qfquw3s) and you'll quickly see why solving the problem of Android OS updates is so important. The 'Platform Version' table (or what I like to call the 'Android comet tale') reveals just how fragmented the Android ecosystem has become. By mid-September 2017 and a year on from launch, Nougat/7.x ran on barely one-in-seven Android devices, while 54.2% of devices accessing Google Play during the week ending 8 August 2017 were still on some form of Lollipop/5.x. That's more than half of all Android devices running an OS version that's basically three years old – hardly a glowing endorsement of the Android update system. Damningly, a quarter of all Android devices are still running KitKat/4.4 or older – the 'comet tail' of older-generations of devices. Throw in the fact that many of these older devices no longer receive security updates and there's clear reason for concern. By contrast, Apple seemed to have solved this issue ages ago and it's only been the release of iOS 10 that has seen Apple end the update life of older iPad 2 and 3 tablets.

PROJECT TREBLE

For Android, however, this is where 'Project Treble' comes into the frame. In short, it's a complete architectural rethink of how Android works, with its goal to make life easier for Google, System-on-a-Chip (SoC) processor

makers and device brands to deliver OS updates to devices on a longer-term basis. Or, ending for consumers what I call the 'pay and pray' model – pay for an Android device, then pray for the OS updates to arrive.

Google itself briefly describes Treble as 'the biggest change to the foundations of Android to date: a modular architecture that makes it easier and faster for hardware makers to deliver Android updates' (tinyurl.com/ycztbqh).

HOW PROJECT TREBLE WORKS

Until Oreo, the Android operating system essentially operated in two major, but not clearly-defined layers – first, the general operating system framework that takes care of the file system, data and apps, followed by a second device-specific layer, the 'vendor implementation'. This layer allows the specific components within your device – the System-on-a-Chip (SoC) processor, the graphics engine, audio, the communications processor talking to your network provider and so on – to talk to the Android OS. Each component section has what's called a 'hardware abstraction layer' (HAL)

acting as a go-between for that hardware component and the operating system, enabling the OS to be somewhat removed from the hardware and to work more easily with the myriad of different hardware components available.

And it works – to a degree. Hardware vendors create a specific ROM for each Android device they release based on a particular Android codebase, but there's no set standard interface between the HALs and the OS – that means while an Android device manufacturer can create an initial device ROM, any subsequent update requires a substantial amount of re-work to hook up new HALs to the new codebase. The cost of doing so is the reason you rarely see updates for budget devices, only for a time for flagship models and why they take so long to appear when they do.

Project Treble re-architects the operating system, formalising a greater separation between OS and hardware abstraction layers to make the whole thing more modular. Google calls this separation the 'vendor interface' and it'll act like a series of universal entry-points. Think of it a bit like how USB mass storage devices work –

Version	Codename	API	Distribution
2.3.3 - 2.3.7	Gingerbread	10	0.6%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	0.6%
4.1.x	Jelly Bean	16	2.4%
4.2.x		17	3.5%
4.3		18	1.0%
4.4	KitKat	19	15.1%
5.0	Lollipop	21	7.1%
5.1		22	21.7%
6.0	Marshmallow	23	32.2%
7.0	Nougat	24	14.2%
7.1		25	1.6%

Data collected during a 7-day period ending on September 11, 2017.
Any versions with less than 0.1% distribution are not shown.



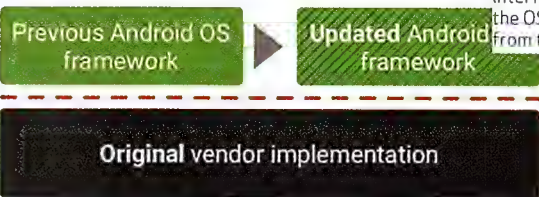
"Many older devices no longer receive updates."

Google's 'dashboard' figures show the OS update problem facing Android.

ANDROID UPDATES BEFORE TREBLE

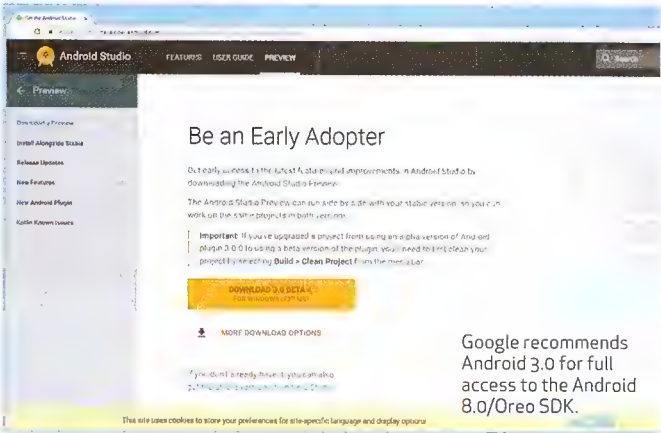


ANDROID UPDATES WITH TREBLE

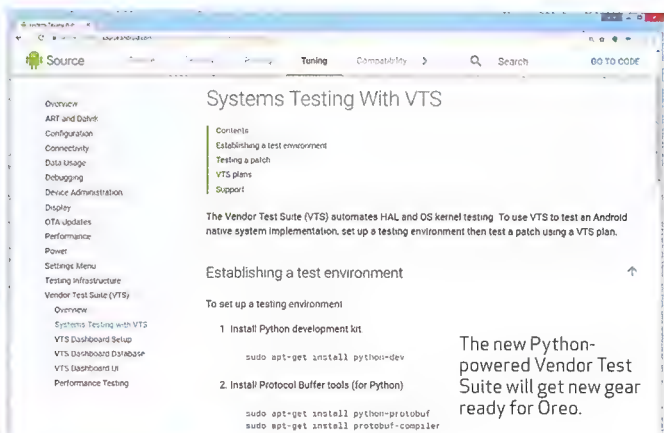


Oreo's new vendor interface separates the OS framework from the hardware.

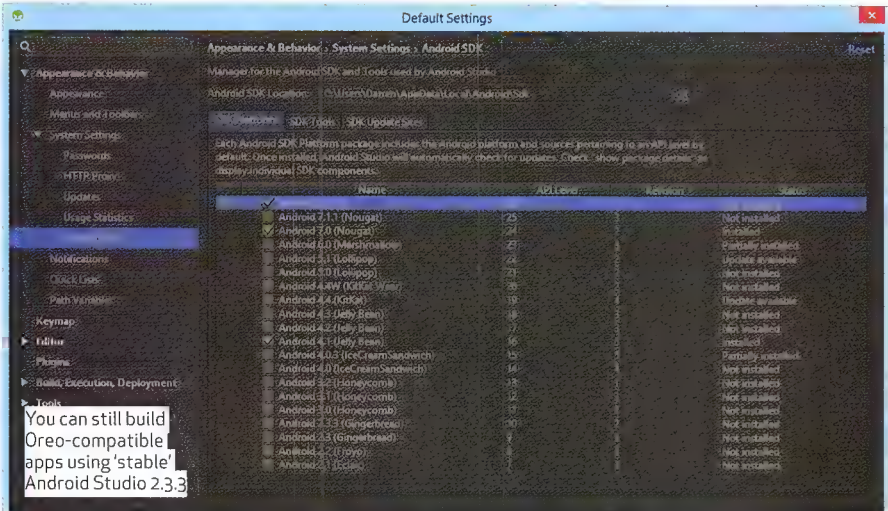
Vendor interface



Google recommends Android 3.0 for full access to the Android 8.0/Oreo SDK.



The new Python-powered Vendor Test Suite will get new gear ready for Oreo.



a standardised USB mass storage device interface ensures any USB flash drive connects and talks with any compatible USB port, regardless of the hardware beyond the interface.

To get hardware vendors on-board, Google has also created a new Vendor Test Suite (VTS) that automates HAL and OS testing (swapping hats for a moment, what's cool about VTS is that it's built using the Python programming language... who said Python wasn't versatile, eh).

WHAT TREBLE MEANS FOR ROMS

Like many Android users, I've been quite partial to my old devices, in particular, my Galaxy S III phone, Samsung's flagship model from 2012 that arrived with Android 4.0/Ice Cream Sandwich, was dumped by Samsung at Jelly Bean/4.3 and has been lovingly supported by the developer community with custom ROMs ever since – right up

to Nougat/7.1.2. However, forum users have complained unofficial releases are often accompanied by reduced overall performance. Now, yes, this could have happened anyway as the result of the ageing SoC, but with loads of previous-generation driver code and typically no official developer help, custom OS/hardware optimisation often has to give way to simply having features work 'well enough'.

But importantly, Treble is part of the Android Open-Source Project (AOSP) release of Oreo and as others have rightly noted, this should make it much simpler to create custom ROMs for new devices in the future. In fact, thanks to Oreo, 'custom ROMs' could take on a whole new meaning. Because of the new vendor implementation layer, an Android ROM will no longer have to include driver code – all it needs are the HAL hooks in place to allow existing Oreo drivers to lock into. That means

ROMs will only need to be 'custom' in their UI or app collection, since Treble should enable a post-Oreo custom ROM to work on any post-Oreo Android device. For the first time, your Android device could start to feel like a PC, where OS updates aren't normally prefaced with the question 'will it work on my device?'. There is one proviso to all of this, however – and that's the need for devices to have unlocked bootloaders that can be pointed to other-than-stock ROMs, a feature some vendors are more attuned to than others.

THE END OF BLOATWARE?

Still, that's not all. If any post-Oreo ROM can work on any device, you could potentially say 'good-bye' to vendor bloatware – just load on your particular brand of vanilla AOSP ROM instead and you're instantly driving a clean, lean device. It sounds awesome in theory and could work on devices purchased 'outright', but we can't imagine it'll be made so easy for pre-paid or contract devices, but we'll live in hope.

WILL MY DEVICE GET OREO?

So, this really is the 'money' question. One clear benefit of buying Google factory-branded devices has been the immediacy with which most receive new OS updates. The Pixel, Pixel XL and Pixel C devices all had Oreo OTA (over the air) and sideload updates on day of release – so too, the Nexus 6P and 5X. That's actually an excellent run for the 5X – near enough to two years old and one of the few Marshmallow/6.0 devices to make the official jump to Oreo. Over the page, we take a look at what we know is happening (so far) with the other major brands.



- **Samsung** – the Korean giant had made no official pronouncements by time of writing, but reports suggest the devices likely to receive an Oreo update include 2017-era Galaxy A3, A5 and A7, the Galaxy S7 and S8, plus their variants, the new Galaxy Note 8, the 2017-versions of the Galaxy J5 and J7, the C7 Pro and C9 Pro, along with the Galaxy Tab S3 tablet.
- **Sony** – the Japanese firm released its update list shortly after Oreo's launch, and includes the Xperia X, Xperia XZ, Xperia XA1 and their respective family variants, plus the Xperia Touch (tinyurl.com/y8p37a7j).
- **LG** – At time of writing, LG was yet to announce its device update list, but it'd be reasonable to assume all of its 2017 flagship releases such as the LG G6 and V30 families get the nod. We like the odds of the Q6, Q8 and V20 also, although when exactly is anyone's guess for now.
- **HTC** – Owners of HTC's U11, U Ultra and 10 phones are confirmed to be soon receiving Oreo updates. The HTC 10 is another Marshmallow/6.0 device lining up for its third Android OS. HTC made an announcement on Twitter, saying the U11 will be first in line with an update during the October 2017 quarter (tinyurl.com/yagq8mgd).
- **Motorola** – With Motorola no longer under the Google umbrella, we won't be surprised if updates roll out slower than they used to. That said, rumours anticipate Motorola releasing the first Oreo updates to the Moto Z and Z2 series, followed by the Moto G4 and G5 models. There's no confirmation on the recently-released Moto C and Moto E4 models, either – assume nothing until Motorola says otherwise.
- **Oppo** – With the R9 still running Marshmallow/6.x, we won't hold our

breath for an Oreo update. The popular R11 with Nougat/7.1.1 on-board is a more likely candidate, depending on Oppo's next moves. The medium-grade F1s and A57 models are also still on Marshmallow/6.x, making these less likely as well.

- **Nokia** – We're certain that the new Nokia 3, 5, 6 and 8, all of which run Nougat/7.x, will receive an upgrade, as Nokia had pledged its phone would get security updates upon release.
- **Huawei** – The Chinese phone maker has reportedly made it official that the Honor 6X and 8 Pro phones will see an Oreo update. Neither of these phones are available to buy in Australia, however, so best guess is a few months of waiting. The company will release its Mate 10 with Oreo preinstalled.
- **Prepaid phones** – budget pre-paid phones locked to a local network provider are popular, but our tip is don't hold your breath for an update. Most low-cost pre-paid models sold in Australia under the \$150 mark are still to reach Nougat/7.x (Motorola's budget \$149-retail Moto C sold with Nougat/7.0 is the only example we know of) and, in our experience, these devices rarely receive updates once you've taken them home.

CUSTOM OREO ROMS FOR OLDER DEVICES

While the number of devices receiving official Oreo updates will be limited, there's still unofficial hope for older devices – if you're prepared for some 'do it yourself'. At time of writing, Oreo has been out and about for just over a week, yet the developer community has already begun churning out unofficial Oreo ROMs for older devices. Keep an eye on xda-developers.com/list-android-oreo-unofficial-ports – this is a growing list of custom ROMs released so far and it already includes

options for popular devices like the HTC One M8, the Nexus 5, plus the Samsung Galaxy S6 and Galaxy Tab S2.

Installing custom ROMs isn't for the faint-hearted, though – there's every chance a custom ROM will still have bugs somewhere along the line and cause your device to malfunction in some way. But if you're desperate for Oreo and your device isn't on its maker's update list, this could be your most likely option.

WILL IT MAKE THE DIFFERENCE?

Unfortunately, it all means that, as good news as Project Treble is, it won't affect the great majority of Android devices, for which, official OS updates are nothing more than a fond yet distant memory. That's a real shame, because as we anticipate, once your device gets aboard the 'Project Treble' bus, future OS updates should be, by definition, all but guaranteed. Still, at the very least, community-built Oreo ROMs could in theory keep devices going until they fall over for lack of speed, not lack of support.

THE BEST REASON TO UPGRADE

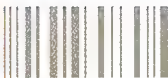
We don't normally suggest things as blatant as this at Masterclass Central, but Project Treble could be just about the best reason we've seen to upgrade your Android device – or at least cross your fingers and toes for an Oreo update. There's no doubt the Android team has put in some seriously hard yards to make Treble work, given the software complexity of what it's trying to do. But if Google has done it right, it could revolutionise the whole Android update landscape – not to mention the benefits to security it should also bring.

Put it this way, Treble is such a fundamental paradigm shift, I won't buy another Android device until I can guarantee it comes with or will receive an update to Oreo. ■



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ON YOUR GADGET WISHLIST?

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Make a scrolling sound level meter

Darren Yates explains how to turn a microphone, an 8x8 LED backpack and an Arduino Nano into a scrolling sound level meter.

Learning to code is one of the most important skills you can pick up – but if you can add to it ‘maker’ skills, understanding electronics and microcontrollers, you open up a whole world of possibilities. Really, the sky and your imagination are the only limits. A couple of months ago, we built a small voice-powered oscilloscope using a budget microphone module. This month, we’re switching the display to an 8x8-LED pack and making a sound level meter with scrolling display that could be used by the hearing-impaired or as the basis of a triggered alarm project.

ARDUINO ANALOG INPUTS

The Arduino Nano is a compact USB-powered microcontroller board with multiple I/O (input/output) pins you can connect up to various devices. It also has a number of analog inputs that connect in turn or ‘multiplex’ to a single analog-to-digital converter (ADC). Digital inputs on the Nano have two levels or ‘states’ – zero-volts, also called ‘ground’ or ‘digital-zero’, and 5V, also known as ‘Vcc’ and ‘digital-one’. By contrast, the Nano’s analog inputs have many levels – up to 1,024 in fact. Those levels are proportional to the input voltage applied to an analog pin, anywhere between 0V and 5V.

CONNECT UP A MICROPHONE

Over the years, we’ve had lots of requests from readers asking how to connect up a microphone to an Arduino analog input. The short answer is you can’t – at least not without help. The problem is, microphones generate a very small voltage on their own, typically

less than one-millivolt (1/1000th of a volt), whereas the Arduino analog input expects the voltage to swing between 0 and 5V. At that rate, a tiny 1mV signal just isn’t going to register. Search eBay and you’ll find this tiny microphone amplifier module pictured for about \$1. It features a microphone and preamplifier, which increases or ‘amplifies’ the audio signal from the microphone to something we can use.

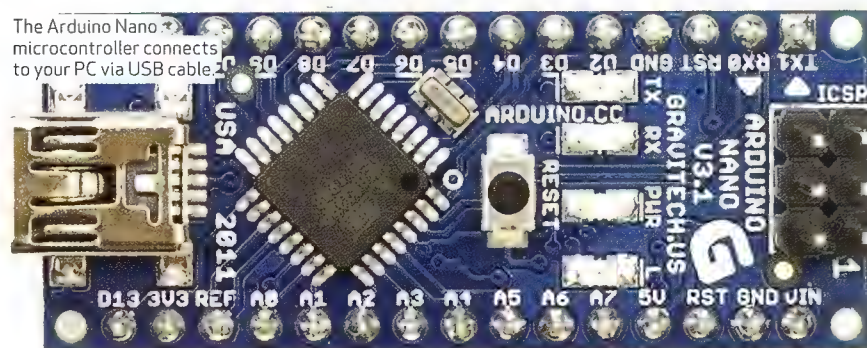
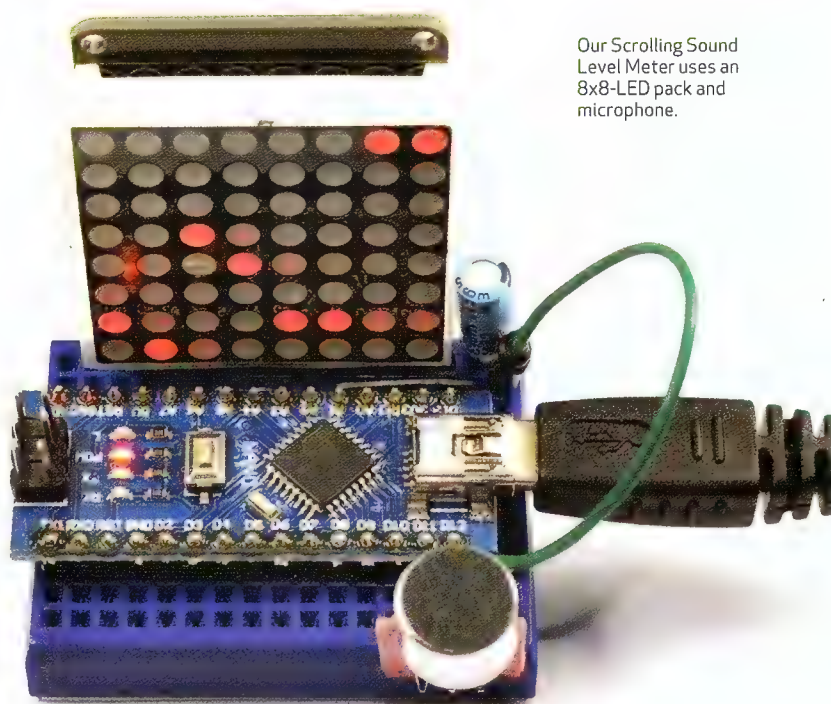
However, we still need to set or ‘bias’ the analog input with a DC voltage that sets the input at half its maximum level. Why? Audio signals are alternating-

current (AC) voltages, which means the voltage swings positive and negative about its steady level. To ensure the Arduino ADC can pick up the whole signal, we bias the input to half the supply rail using two 10kohm resistors and connect the output from the microphone amplifier via a 10uF capacitor, allowing the audio (AC) signal through to the analog input but blocking the DC voltage.

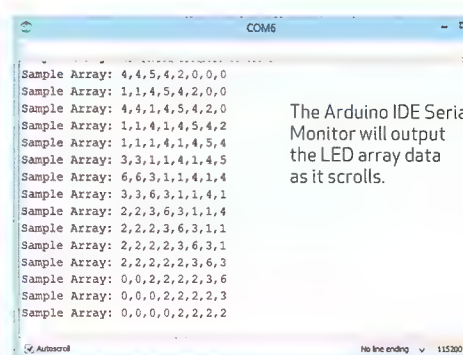
HT16K33 LED PACK

The only other major component, apart from the Arduino Nano on the

Our Scrolling Sound Level Meter uses an 8x8-LED pack and microphone.

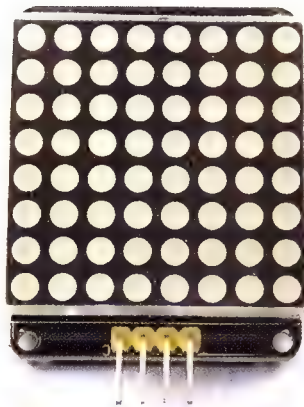
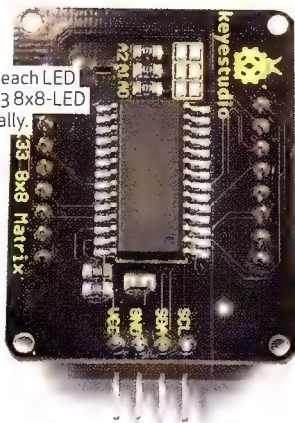


The Arduino Nano microcontroller connects to your PC via USB cable.



The Arduino IDE Serial Monitor will output the LED array data as it scrolls.

You can code each LED in the HT16K33 8x8-LED pack individually.



170 tie-point breadboard, is the KT16K33 8x8-LED pack. It only has four pins to connect up all 64 LEDs, but does so through its own microcontroller chip and talks to our Arduino Nano chip over a digital interface connection or 'bus' called 'Inter-integrated circuit' or I2C. The Nano only has one I2C bus, located on analog pins A4 and A5, which is where we plug in the LED pack. However, since pins A2 and A3 are also available, we switch these analog inputs into digital outputs using software, setting A2 to 5V output and A3 to ground, creating a simple power supply to run the LED pack. Normally, this isn't a great idea, because these pins can only supply 40mA of current before they get cranky. But by setting the brightness to near-minimum, we can keep the display's demand for current down to happy levels and the whole thing works.

HOW THE CODE WORKS

That's the hardware, now for the Arduino code or 'sketch'. What we want to do is have the display scroll at the rate of roughly 10fps, so that any audio noise will register vertically and proportional to its volume, while scrolling across the display. To do that, we start with creating a special code device called a 'timer' using the SimpleTimer library. It allows us to create a trigger every 100milliseconds that launches a separate code function we call 'updateMeter'. It updates the display with the latest sound values. This code function only takes a few milliseconds to run, so for the rest of the time, the Arduino is sampling the analog input A1 and recording the largest digital value during that time. Recording the largest value is important, for otherwise, a short sound burst could register a value

but disappear back to zero before the next display update function trigger occurs and we don't see any display change. By recording the maximum sound level for that period, even the shortest peak, say from clapping your hands, is recorded and displayed. This is the same basic technique used in most sound alarms.

BUILDING THE PROJECT

We purchased all the components from eBay and built the whole thing on a tiny 170-tiepoint breadboard. Use the overlay wiring diagram as a guide to building your own. Really, it shouldn't take you more than 15 minutes. The next task is flashing the source code to the Arduino chip. For that, grab our source code pack from our website (apcmag.com/magstuff), unzip the file, copy the contents of the /libraries subfolder into the same of your Arduino IDE installation (don't have the IDE? Download the latest version free from arduino.cc/downloads). Shut down the Arduino IDE and restart it so the new libraries take hold. Select File > Open and choose the 'soundmeter v1.ino' source file from the download, then choose Tools > Board and set it to 'Arduino Nano'. Plug the Nano board into computer via a USB cable. Back on the Arduino IDE, select Tools again, this time choose Port and select the COM port for your board (don't choose COM1, that's your mouse). Now when you're ready, select Sketch from the menu and Upload – the source code will compile and begin uploading to the Arduino Nano board (you should see LEDs on the board start flashing). Provided you've build the project, the bottom row of the 8x8 LED pack should light up a second or two after the upload is complete. Make a noise into the microphone and it should register and scroll across the display. If so, congrats – you're done.

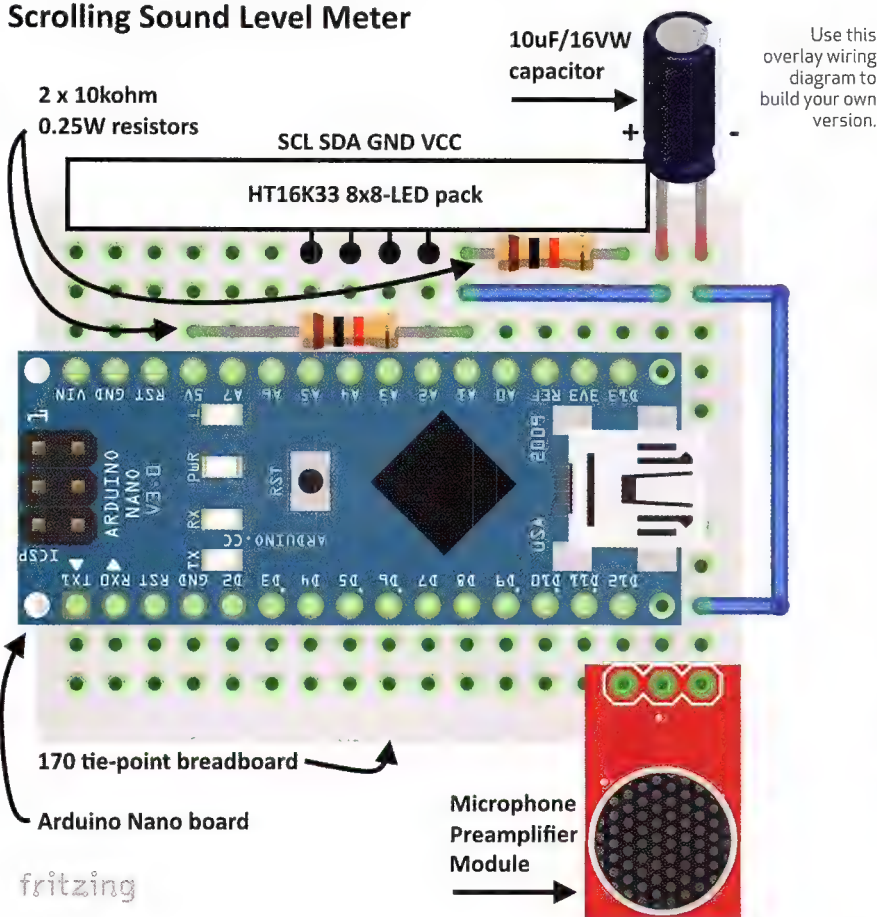
SERIAL MONITOR

Clicking the green magnifying glass icon at top-right of the Arduino IDE window starts the Serial Monitor, which displays data coming back from the Arduino – in this case, the array of LED values as they scroll across. Come up with your own code to get the Arduino to send across a trigger code to launch your own code to sound an alarm, send a tweet or an email – your choice. ■

You'll find this tiny three-pin microphone amplifier module on eBay for \$1.



Scrolling Sound Level Meter



Plot your data in Python

Learn how to programmatically draw charts using the use the matplotlib library with Python. Darren Yates explains how.

Python is one of the world's most popular programming languages – and it's not too hard to see why. It's free, easy to learn and incredibly versatile. Already, we've looked at how you can use Python to read data from your car's engine control unit (ECU) and how Python can tap into features such as Speech Recognition on your Android device. The language is also equally adept at online activities, for example, Django (djangoproject.com) is a popular web framework for developing complex websites using Python code. But Python is also popular in scientific, mathematical and statistical circles, thanks to its highly-advanced ability at drawing charts and plots via the matplotlib library and the SciPy stack.

GET PYTHON

Not sure if you have Python installed on your computer? That's easily fixed – launch a command prompt on your Windows PC or terminal on your

macOS or Linux system, type `python` and press Return. If all you get is an error message, it's not installed. In that case, head to python.org/downloads and grab the latest version of Python 3 (we use Python 3 here at Masterclass Central). Launch the installer to install it onto your system.

PYPI – APP STORE FOR CODERS

When you run Python for the first time, it only comes with one library called the Python Standard Library – still, that one library is chock-full of functions and extensions, covering everything from the basics of `print()` and `input()`, through to multimedia, database, web, file input/output (I/O) and beyond.

However, it doesn't do everything and for the things it can't do, software developers create their own libraries, which is why the PyPI – Python Package Index – exists. Think of it as the App Store for Python programmers. At last count, it contained over 116,000 separate downloadable and code-able

Python packages that you can import and include in your code. We've already used the Python-OBd library from here to read car engine computer data. You can browse through the index online by heading to pypi.python.org/pypi and tapping 'Browse packages' from the left-side menu.

INSTALL MATPLOTLIB LIBRARY

Creating charts and plots might not seem the most exciting thing you can do with Python, but matplotlib can do some seriously cool tricks we can't show on paper – tricks like chart animations that are impressive to watch. To install matplotlib, we need 'pip' – the Python package installer that comes bundled with the standard Python download. You can quickly check to see if pip is part of your system's environment path by launching a command prompt, typing 'pip' and pressing enter. If you get details of pip's command switches, you're good to go. If not, Windows users should find pip located in the subfolder

```
Python 3.6.1 Shell
File Edit Shell Debug Options Window Help
Python 3.6.1 (v3.6.1:69c0db5, Mar 21 2017, 17:54:52) [MSC v.1900 32 bit (Intel)]
on win32
Type "copyright", "credits" or "license()" for more information.
>>> import matplotlib
>>> import numpy
>>> import scipy
>>> |
```

Use 'import' statements to check these libraries are correctly installed.

```
simple_anim.py - C:/Users/Darren/Downloads/simple_anim.py (3.6.1)
File Edit Format Run Options Window Help
A simple example of an animated plot
14:29:29
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.animation as animation

fig, ax = plt.subplots()

x = np.arange(0, 2*np.pi, 0.01)
line, = ax.plot(x, np.sin(x))

def animate(i):
    line.set_ydata(np.sin(x + i/10.0)) # update the data
    return line,

# Init only required for blitting to give a clean slate.
def init():
    line.set_ydata(np.ma.array(x, mask=True))
    return line,

ani = animation.FuncAnimation(fig, animate, np.arange(1, 200), init_func=init,
                             interval=25, blit=True)
plt.show()
```

The matplotlib 'simple_anim.py' plot animation does a lot for few lines.

```
helloplot.py - C:/Users/Darren/Python Code/Python_EP_16/helloplot.py (3.6.1)
File Edit Format Run Options Window Help
# APC Masterclass - Learn to code Python
# Issue #447 - SciPy stack
# 6-September-2017 Darren Yates
# Hello Plot

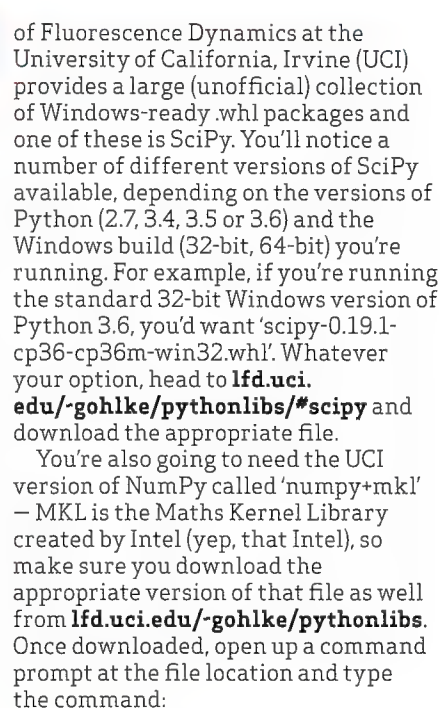
import matplotlib.pyplot as plt

pltX = []
pltY = []

for x in range(0,11):
    pltX.append(x)
    pltY.append(x*x)

plt.plot(pltX,pltY)
plt.title("APC Magazine - Hello Plot")
plt.ylabel("x-squared")
plt.xlabel("x")
plt.show()
```

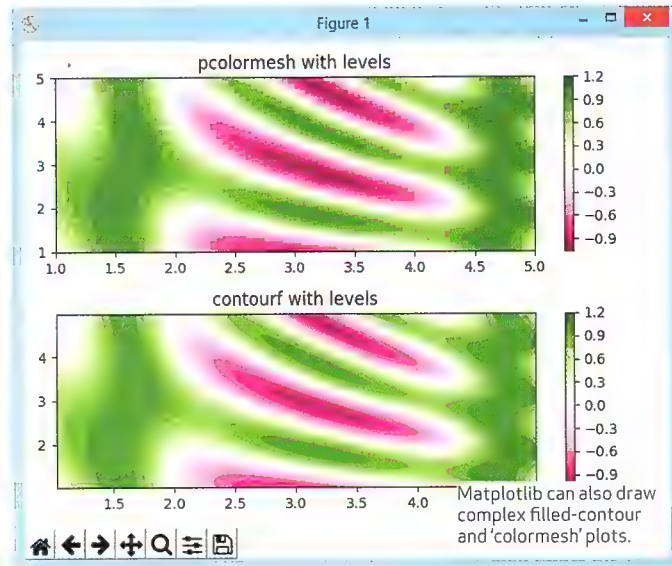
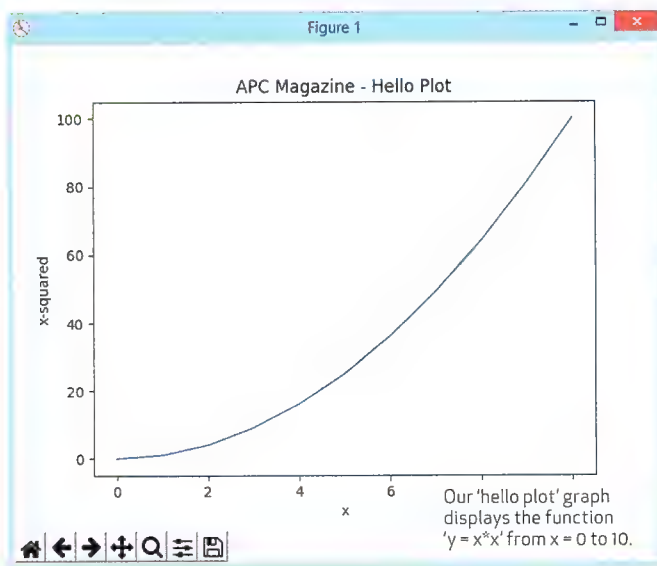
The code for our super-simple 'hello plot' chart.



You must install them in this order, otherwise SciPy won't install correctly. That aside, once the installs are done, you'll now have ready-to-use what's often termed the 'SciPy stack', the collection of Python libraries used most often in maths, science and engineering fields. To check they're good to go, launch the Python IDLE environment and type:

However, if you're going to install matplotlib, the chances are pretty high you're also going to need NumPy, a library package that, among other

If you're running macOS or Linux, you can install these libraries easily through pip and PyPI. Unfortunately for Windows users, the PyPI version of SciPy doesn't install correctly using pip, but there is an alternative. Python packages are known also as 'wheels', from their '.whl' file extension. Christoph Gohlke, from the Laboratory



```
import scipy
import numPy
import matplotlib
```

Pressing Enter on each one. If you don't see any error messages, you're done.

RUNNING EXAMPLE CODE

Now we're ready to run some code and rather than having to start from scratch, matplotlib has some excellent and impressive examples for you to play with. Head over to matplotlib.org/examples/index.html and start by downloading the 'simple_anim' source code from the 'animation Examples' section. Open it in Python IDLE and run it (press F5). Within a second or so, you should start seeing a scrolling sine wave display in a separate window, a bit like an oscilloscope screen. Animations can be really useful for plotting data because they can help identify patterns not easily visible in fixed single-frame chart.

Another really cool animation is the 'double_pendulum_animated' example – this one needs the full SciPy stack, so it's also a good test to ensure you have everything installed correctly, otherwise it won't work. It might look quite basic – a double pendulum swinging under the influence of gravity – but the fact it's all modelled in mathematical formulas is really

cool. Not only that, you can also tweak the settings to see how a change of gravity constant, pendulum mass and length change the swing pattern.

One more simple example that's really clever is 'wire3d_demo'. It's only half-a-dozen lines of code to produce a three-dimensional wire plot of some data, but if you click-and-drag the plot area, you can spin it around in 3D space and see the 3D surface of the data. Well, even if it's not particularly your cup of tea, it's still damn impressive, if for no other reason that just how little code is required.

MAKING YOUR OWN CHARTS

Nevertheless, while playing around with examples is an ideal way to start (as you can see how various commands are used in practice), there's nothing like having a go at writing your own code. We'll get you started with a 'hello world' simple chart, just to break the ice. Grab this month's source code pack from the APC website (apcmag.com/magstuff) and load the 'hellochart.py' source file. The basic 2D chart function inside matplotlib is called 'pyplot', so we start by importing this into our code as the object 'plt'. We then create two lists or arrays called 'pltX' and 'pltY'. The for-loop creates the data, adding the numbers 0 to 10 to pltX and the square of those numbers to pltY.

The hard work is done by the next line:

```
plt.plot(pltX, pltY)
```

This creates a two-dimensional (2D) line plot with pltX on the horizontal or X-axis and pltY on the vertical or Y-axis. We then use the title() function to add a title, along with the xlabel() and ylabel() functions to add axis labels. Finally, we display the chart using the show() function.

The key thing to notice is how little we had to do – the pyplot module does all the drawing, ensures the Y-axis title is rotated, even creates the window and selects the line-plot colour. You can edit all these parameters if you wish, but it's great to know you can throw together a quick plot with just a few lines of code.

HOW ANIMATIONS WORK

The easiest way to understand how plot animations work in matplotlib is to take a look at the code in an example file. The 'simple_anim.py' source code we looked before is an ideal place to start.

Animations are part of the animation module within the matplotlib library. The 'simple_anim' Python code begins with importing the three main modules required – the NumPy library plus the pyplot and animation modules. Next, the code

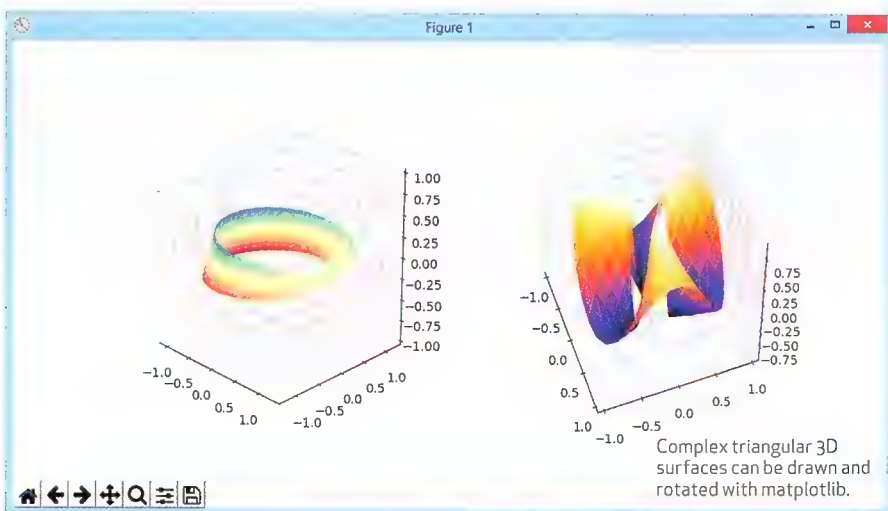
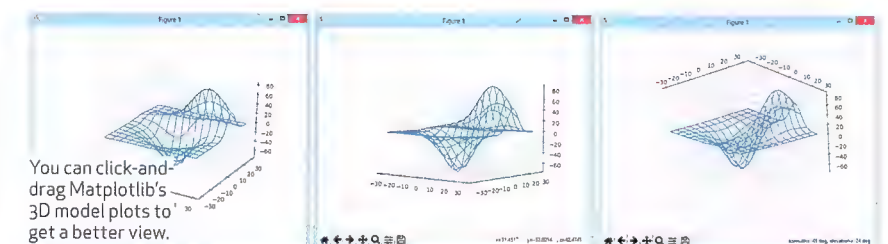
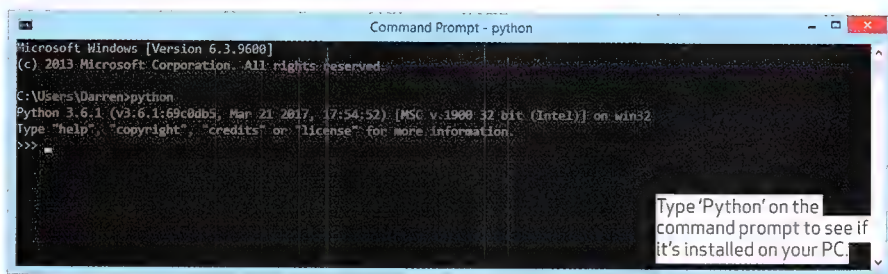
```
C:\Windows\system32\cmd.exe

C:\Users\Darren\Downloads>pip install numpy-1.13.1+mk1-cp36-cp36m-win32.whl
Processing c:\users\darren\downloads\numpy-1.13.1+mk1-cp36-cp36m-win32.whl
Installing collected packages: numpy
Successfully installed numpy-1.13.1+mk1

C:\Users\Darren\Downloads>pip install scipy-0.19.1-cp36-cp36m-win32.whl
Processing c:\users\darren\downloads\scipy-0.19.1-cp36-cp36m-win32.whl
Requirement already satisfied: numpy>=1.8.2 in c:\users\darren\appdata\local\programs\python\python36-32\lib\site-packages (from scipy==0.19.1)
Installing collected packages: scipy
Successfully installed scipy-0.19.1

C:\Users\Darren\Downloads>
```

Download numPy and SciPy from the UCI Python wheel website (see text).



creates two matplotlib.figure objects called 'fig' and 'ax' – these are known as 'tuples' (kind of like a list or an array). They're created using the subplot() function and contain the figure or plot we want to draw. After that, the 'np.arange' statement sets up a single-dimension array ranging from 0 to $2 \times \pi$ (6.28...) stepped at 0.01 intervals. The line following creates the plot of the sine wave, with 'x' on the X-axis and 'np.sin(x)' on the Y-axis.

Now we come to two Python functions – animate() and init(). The first is responsible for stepping through the animation while init() begins the animation cleanly.

Finally, there's the 'money' statement – the animation code itself. As you can see, it's just one line:

```
ani = animation.  
FuncAnimation(fig, animate,  
np.arange(1, 200), init_  
func=init, interval=25,  
blit=True)
```

Matplotlib has two animation methods – FuncAnimation and

ArtistAnimation. The main difference between them is FuncAnimation derives each frame change from a function or formula, while ArtistAnimation is a series of pre-fab frames ready to draw.

FuncAnimation has a number of parameters that determine the what, how and when of the animation. The most common way to animate computer graphics is to create a code device called a 'timer', which fires off a trigger after a pre-defined interval, launching a particular code function that updates the animation with a new frame (we've used something similar in this month's Arduino Masterclass and our scrolling sound level meter project). Matplotlib uses this same technique. The parameters list (inside the braces) begins with the 'fig' plot object we want drawn, the second parameter is the 'animate' function to be called each time the timer triggers. Next, the np.arange() function creates an array of integers from 0 to 200. FuncAnimation allows you to set an initialising function (init_func), called the first time the FuncAnimation() code runs. The

'interval' variable contains the timer delay between frames (25-milliseconds), while 'blitting' is a technique for ensuring the animation is smooth. Last of all, the plt.show() statement displays the animation.

It'll probably seem quite complicated the first time you look at it, but when you consider how much is being hidden by those few commands, it's no wonder matplotlib is popular.

At this point, the thing to do that I can't recommend enough is to play around with the myriad of code examples – change parameters, edit code, even break the code to see how it all works. Keep a copy of the matplotlib API documentation nearby (matplotlib.org/api/index.html) so that you can understand why functions perform the way they do and what each of the parameters does.

LOTS MORE FEATURES

We've barely scratched the surface of what matplotlib's animation functions can do, let alone the rest of matplotlib library itself – for instance, the animation function can even tap into the Ffmpeg video transcoder if you install it onto your PC and turn animations into video files using whichever video codec you like from its libavcodec library. Combine NumPy, matplotlib and SciPy together and it's no surprise Python is so popular within the mathematics, science and engineering communities.

SIMPLER INSTALLATION OPTIONS

The basic IDLE editor included with the standard Python install is serviceable, but as you start getting into more complex tasks requiring multiple libraries, like the SciPy stack, there are potentially easier ways to get moving. There are plenty of alternative Python-ready or Python-specific IDEs with a more advanced flavour and we'll look at some of them in a future issue, but two worth looking at are WinPython (winpython.github.io) and Anaconda (www.anaconda.com). Both incorporate Spyder, an IDE designed for the scientific community, with the SciPy stack installed ready to go.

CODE IT YOURSELF

The great thing about programming is the power and freedom it gives you to roll out your own apps to fill gaps and solve problems, whether it's at home or at work. But it's also the ability to mod your code as required without needing someone else doing it for you. If you've never learned to program before, now is a great time and Python is arguably one of the simplest and most versatile languages around. Why not start now? You won't regret it. ■

downtimegames

» EDITED BY CARMEL SEALEY



You have three distinct character classes to play with and customise.

PC, PS4, XO | FROM \$89.95 | WWW.DESTINYTHEGAME.COM

apc
HOT PRODUCT

Destiny 2

Save the solar system by becoming Earth's lightest hero

One year after *Destiny's* last expansion, *Rise Of Iron*, emperor Dominus 'Gary' Ghaul leads his Cabal forces to Earth and steals everyone's power for himself, severing the link between you and magic-bestowing orb The Traveler before vowing to blow up the sun. Your newly vulnerable Guardian must venture across the Solar System acquiring Light (think supernatural prowess) to stop Ghaul and his Red Legion. And maybe learn a cool new emote while they're at it.

All your efforts in Bungie's original massively multiplayer shooter reset, and that's great for everyone. This is a sequel beckoning newcomers and incentivising pros to experiment with awesome new weapons and classes. You start by choosing your Guardian, whether no-nonsense human, rainbow-

coloured awoken, or hairless exo, then use a creation suite to make, say, a plum-coloured avatar with blue lips and a feathery mullet.

Once that's done you soon settle into a pattern: venture out alone or with other Guardians across several hub worlds in efforts to kill aliens and loot increasingly rare gear; join impromptu public events and team up to destroy durable mechs or repel a brief enemy blitz; embark on more structured Strike

missions for up to three people; or perform tasks for the area's stationed NPC, like gentleman sniper Devrim, who has us clearing mines and planting beacons. There's just as much to do alone as there is with others, and the story rolls on nicely.

It's a testament to the sensational gun-feel that *Destiny 2* resists stagnation. Shooting is tighter, snappier, and buoyed by a surge of punchy new feedback effects, even more entertainingly evergreen.

The three new breeds of weapon initially seem like a lateral move, fixing what didn't need to be fixed, this frees up loadout building and removes unnecessary restrictions.

Every element in *Destiny 2* has been considered, reconsidered, and iterated upon, from wholesale campaign improvements, luscious levels, better Strikes, and powerful new classes, to weapon reorganisation and a UI spruce. Rather than introducing major new features, *Destiny 2* expands out like the Big Bang, at once immediately exciting and immensely promising.

■ Ben Griffin



Verdict

Whether chatterbox, lone wolf, newcomer, or old hand, *Destiny 2* is unmissable.





PC, PS4 | \$44.95 | LAWBREAKERS.NEXON.NET

LawBreakers

A gravity defying arena shooter for the ages.

LawBreakers has people talking about three things in the lead up to its release: that it's a modern take on the reflex-oriented arena shooter (good), that it's an *Overwatch* clone (bad) and that it's made by *Gears of War* creator Cliffy B (good or bad, depending who you ask). Only two of those are true: yes, this is a first-person shooter with "heroes" or, for the newcomer, distinct playable characters with their own roles and abilities. It's no *Overwatch* clone, and to a certain type of player *LawBreakers* will wipe the floor with Blizzard's sensation.

It's a multiplayer-only shooter with a steep learning curve, and you'll have to get to grips with its breakneck pace and the initially fiddly specialties each playable character brings to the table. You've got your machine gun-wielding heavies, your shotgun wielding tanks, your dual pistol toting midrangers. All have special high speed or vertical movement abilities, and all lose their gravitational pull to the ground in certain



areas of the game's handful of maps. It's an objective based shooter, so don't expect to log in and shoot at things unthinkingly: a certain amount of team awareness is required.

All the usual pointless modern adornments are here: there are lootboxes featuring special character and weapon skins, and prettier ways to decorate your player avatar. But aside from this (and the variety in characters), the game feels like ye olde *Quake* or *Unreal* but faster and more intense. Health is picked up rather than regenerated, and even the lighter characters have a reasonably high time-to-kill. But it's the sheer joy of moving around that

LawBreakers nails: the verticality, the airborne combat, the floaty low gravity freedom.

Right now, *LawBreakers* doesn't have a huge playerbase, neither on PC or PS4. On the latter, which we reviewed, it wasn't hard to get a game, though we'd often have to wait around five minutes. That's a shame, but doesn't mean you should rule *LawBreakers* out.

■ Shaun Prescott

Verdict

Now is the best time to get your \$50 worth for a game which deserves a chance to flourish.



Observer

Jacked in, freaked out

PC, PS4, X0 | \$44.95
OBSERVER-GAME.COM

Bloober Team's last psychological horror, *Layers Of Fear*, hid its scares behind you. *Observer* confronts you with the cruelty of its cyberpunk dystopia from the outset. The titular observer, Daniel Lazarski heads to a run-down apartment complex to find his son. First he finds a body, then a plague warning sees the complex put on lockdown. And things only get worse.

Ostensibly, this is a detective game. You traipse between crime scenes, finding clues and jacking into the corrupted memories of augmented victims to understand their last moments. It's well-realised, and exceedingly creepy.

Around half the doors in the single complex you explore have someone behind them, ready to have a (usually horrible) chat. We learn two sides of this world's morality from an augment-clean religious fundamentalist and a chilling pleasure robot, its history from tossed-aside war veterans, and its day-to-day life from stressed dads. On rare occasions these lead to side-quests, which arguably contain *Observer*'s best moments, and a story that feels much bigger than most Triple-As will manage this year. ■ Hal Tarrare





apc
RECOMMENDS

Tacoma

A sci-fi mystery from the creators of *Gone Home* set on a mysteriously abandoned space station.

PC, X0 | US\$19.99
TACOMA.GAME

Drifting somewhere between the Earth and the Moon, the lunar transfer station Tacoma lies empty and abandoned. An incident has forced the crew to evacuate and you, Amy Ferrier, have been sent to investigate and recover its omnipresent artificial intelligence, Odin. But even though the six people who ran the station are long gone, their presence is keenly felt. And not just because of the empty cups, photos of loved ones, and other traces of life they left behind

Venturis, the megacorporation that owns Tacoma, has 3D recordings of every second of the crew's year aboard the station, which you've been granted access to. And it's through these ghostly memories that you'll learn about the people who lived and worked there before the incident. It's a compelling mystery that grabs hold of you the instant your magnetic boots clamp to the station and never lets go.

There's a lot going on in *Tacoma*, much of it subtle, hidden away, waiting to be uncovered. And in that sense, as a game about piecing together a story, it's immensely rewarding. I won't forget my time aboard that station any time soon, or the people whose lives I got hopelessly tangled up in while I was there. ■ Andy Kelly



apc
RECOMMENDS

PS4 | \$49 | WWW.PLAYSTATION.COM

Uncharted: The Lost Legacy

An Indian summer for Naughty Dog's flagship series

Chloe Frazer's turn in the spotlight has been a long time coming. Since stealing the early hours of *Uncharted 2*, the Indo-Aussie's had to make do with being the flirty love interest, but this jaunt through India not only makes up for this, but makes a convincing argument for her inheriting the series from its previous star.

It's all down to the writing. Once again, Naughty Dog finds a way to take an archetype and sketching in details to flesh it out. So while Chloe might start as an overly glib adventurer, we see how her knowledge of Indian history and her past shape her humour-as-defence-mechanism outlook. Plus, teaming her with Nadine Ross is a masterstroke, allowing both characters to slowly reveal themselves to one another and us. While Nadine gets less to do, she nabs the best lines (her casual monkey facts are better than anything she does in *Uncharted 4*). Their chattering has a lovely ebb and flow throughout, not least in the mammoth

chapter The Western Ghats.

While we associate *Uncharted* set-pieces with noise and falling debris, *Lost Legacy*'s stand-out feature is the largest level in an *Uncharted* game to date. Initially, the freedom is exciting, as you tear off towards the nearest landmark or stumble across hidden areas. Like the Madagascan savannahs of *A Thief's End*, it's both lovely to look at (full of vibrant foliage and spectacular vistas) and allows the enjoyably freeform combat to sing. Wide-open areas full of grass to hide in and grapple points enabling you to swing between places quickly cater to differing approaches, although most exploration ends up in a chaotic ballet of dodging shots and throwing punches.

But it's not without problems. Puzzles aren't a strength of the *Uncharted* series, yet they dominate this section of *The Lost Legacy*. All are simple enough, but never feel that involving because of it, and often feel like leg work before you get back to the good stuff.

Plus, the usually

relentless pace drops off a bit here. With so many collectibles, optional conversations, and secrets to discover, you could lose hours just hoovering up trinkets, but if you prefer to focus on the story objectives, you'll have the uneasy feeling you're missing out on more than usual. There's plenty to like here, but it's not quite the home-run you would expect.

Fortunately, Naughty Dog eases back into what we expect from the series after this detour: the white-knuckle moments where everything seems to be collapsing, quips flying as fast as the bullets as Chloe and Nadine go hunting for the Tusk Of Ganesha. It plays out like a grab-bag of ideas that are easy enough to spot from *Uncharted*'s past, yet utterly sweep you up in the moment. If this is a swan song then it's a worthy one. ■ Ben Tyrer

Verdict

A decent start blossoms into a rush of 'greatest hits' set-pieces that will leave *Uncharted* fans eager for more.





SWITCH | \$89.95 | WWW.MARIO-RABBIDS.COM

Mario + Rabbids: Kingdom Battle

No bad hare day, here!

It's somewhat ironic that the first game on Nintendo Switch starring Mario hasn't actually come from the big N itself. Instead, this cross-over title sees Ubisoft's Rabbids (a race of bonkers and unhinged rabbits) invading the Mushroom Kingdom, and it's up to you to lead Mario and friends to reclaim the land in a series of *XCOM*-style turn-based battles.

And *M+R* undoubtedly owes a big debt to the latter series, although it stays on the right side of the 'homage' line by bite-sizing and simplifying the action, and doing away with any kind of base-building. In essence, it successfully distills the *XCOM* formula down into the most fun bit — the battles — and excels at it.

Each fight has you leading Mario and two companions from a roster which includes traditional sidekicks (like Luigi and Princess Peach) or Rabbids who've been crossed with the latter. Each character has their own combination of unique special abilities and weapons — Rabbid Peach, for example, is basically

your medic, able to heal other characters around her, while Luigi is your sniper, with a weapon that shoots 50% further than most others. (Of course, this being a family-friendly Mario title, all those weapons are completely non-fatal — 'killed' enemies are merely beamed off the battlefield.)

Different battles have different objectives as well, and along with constantly changing landscapes, that helps keep *M+R* feeling fresh. Sometimes, battles require you to clear the field of all enemies, while others challenge you to reach a certain area or escort an NPC. Like *XCOM*, you need to keep your characters behind cover and work to flank your enemies if you want to succeed. You won't always win, either: the game gets tougher as it goes along, and time (or turn) limits or just having selected the wrong roster for a certain battlefield or set of enemies can scupper your chances.

When you do win, you'll earn gold coins, which can be used to purchase upgraded weapons, alongside Orbs, which can enhance your character's

abilities — so Rabbid Peach can heal more damage, for instance — unlock new ones, or just improve basics, like how far a character can move per turn.

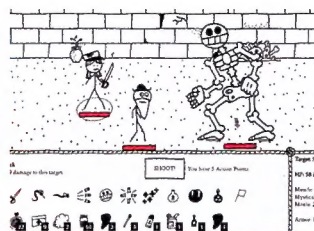
The campaign takes place over four worlds, each with nine sections which can consist of one to three battles apiece and, once you've cleared a world, you can come back and it'll have a whole new set of smaller 'challenge' battles for you to beat. Progressing from fight to fight involves leading Mario around a 3D world and some light environmental puzzling — pushing blocks around to open up new paths, mostly.

Ubisoft's done a wonderful job with *M+R*, and it makes for a very approachable turn-based strategy game that'll appeal to both genre fans and newcomers alike. You'd be rabbid to miss it.

■ Dan Gardiner

Verdict

Boils *XCOM*'s turn-based formula down to its most fun bits to create an approachable and enjoyable romp.



West of Loathing

3:10 to Humour

PC | US\$11
WESTOFLAGGING.COM



Welcome to the Old West, where snakes are used as whips, cattle are demonically evil, and alongside stick-figure cowboys there are goblins, necromancers and a lot of ghosts. There are ghost horses—I ride one myself—and ghost cowboys. There are even ghost pickles, and they're not the strangest food you'll encounter.

A comedy RPG, *West of Loathing* is goofy and wonderfully written. After choosing from one of three classes—the magical Beanslinger, the smooth-talking Snake Oiler, or the rough-and-tumble Cowpuncher—you'll journey through tiny towns, gang hideouts, and a Daveyard (which is like a graveyard, but only Daves are buried there).

The wit sells it. Flush a toilet for an XP gain, search a haystack for a needle, or dig through a mine cart for a hunk of meat ore (*West of Loathing* has a meat-based economy). Insult yourself in a mirror to gain a combat buff because you angered yourself so much. There are branching text conversations with a cast of oddball characters that are almost always entertaining, and everything from item descriptions to menu options are fun to read. Where *West of Loathing* falters is with its turn-based combat, but overall is both fun and funny from its opening to whenever it is you decide you've read every last word in the game.

■ Chris Livingston

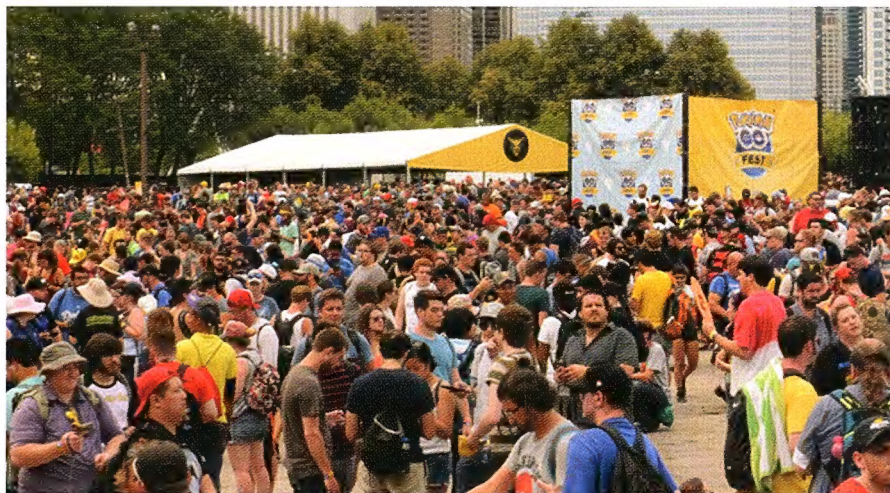




Lego fan recreates retro computing scenes

Not just another brick in the wall.

PowerPig is, we can honestly say, one of the more interesting things we've found on the internet of late. Not only is Chris McVeigh (the Pig himself) an author, illustrator and photographer, he's also a Lego enthusiast, responsible for some of the best building kits out there. Some of these include a handful of bonsai trees, hamburgers and slices of birthday cake, retro cameras, a full arcade, air hockey table, old-school radio and — the best yet — retro TV sets, Nintendo and Atari consoles, and a desk setup complete with an old computer, filing cabinet and wheelie chair. What McVeigh has achieved here is thoroughly amazing and is a testament to the longevity of Lego itself.



Pokémon GO Fest fail

SERVER ISSUES AND BUGS SPOIL THE AUGMENTED FUN.

Events at Niantic's Pokémon GO festival in Chicago didn't go quite as planned. With reception far from ideal, festival attendees were disappointed to find that the servers were crippled due to an overloaded network, preventing them from logging in. Niantic CEO John Hanke was booed during the opening ceremony and cries of "Fix the game!" could be heard. One of the big attractions was the opportunity to catch rare Pokémon in and around the festival, and to participate in a raid battle. Since many had flown in from around the country and overseas, the offer of a ticket refund and US\$100 of in-game currency didn't do much to quell the anger.



Dadbot

THE FACEBOOK MESSENGER CHATBOT SPEAKING WITH A VOICE FROM BEYOND THE GRAVE.

James Vlahos, it seems, is going through a stage of grief that Ross and Kessler never could have imagined — creating a chatbot of your deceased loved one. 'Tis I, the Beloved and Noble Father! were the first words the Dadbot uttered, but rather than being an uploaded conscience-style AI like what we saw in the movie *Transcendence* (saw and didn't overly enjoy), this chatbot is an amalgamation of 12 hours of transcribed recorded dialogue between James and his now-deceased father. Those 90,000 words were then fed into PullString, a program designed to create chatbots, and from that, Dadbot emerged. While James can now hold a conversation with the Dadbot, he admits that it's far from perfect and that "it's not nearly so good that it's creepy." Well, that's good. Right?

Drop iPhones, not bombs

UNIQUE SOLUTION SUGGESTED TO THE NORTH KOREA CRISIS.

At APC, we try not to get into politics, providing a glorious tech-based bit of escapism for you — our readers — each month (you're welcome!). But for once, we will make an exception. "Why?" you may ask. Well, a former US Navy SEAL by the name of Jocko Willink has come up with a potential solution to the impending end-of-the-world North Korea H-bomb crisis, which isn't the usual 'just drop a bomb on them' avenue. "Drop 25 million iPhones on them and put satellites over them with free wifi," Willink tweeted early in September. North Korean expert Yun Sun has said that the concept of arming the North Korean people with knowledge, in theory, has its merits. However, getting the phones across the border and into the hands of the population, and also keeping the ordinary citizens from getting punished by the regime before then rising up and overthrowing Kim Jong-Un and his ilk is easier said than done.

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